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FLORISTIC NOTES ON THE LICHEN AND LICHENICOLOUS FUNGI FLORA OF ALBERTA, CANADA

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While examining herbarium material kept in ALTA and recent field collections, several taxa not listed in a preliminary inventory of the lichen flora of Alberta (Anonymous 1990) were discovered, among which the widespread Diploschistes muscorum, and the two euoceanic Lobaria hallii, and Nephroma isidiosum. In addition, Diploschistes diacapsis is reported as new for Canada, based on a single collection from Alberta. By contrast, Lobaria oregana is deleted from the Albertan flora. Further, three lichenicolous fungi, namely Cortifraga fuckelii, Pronectria erythrinella and Illosporium carneum, are reported for the first time for the Province. Most of these floristic observations represent significant range extensions.

Cortifraga fuckelii (Rehm) D. Hawksw. & R. Sant.

This lichenicolous fungus was found growing on Peltigera rufescens (Weis) Humb. inhabiting a steep slope with an open subalpine vegetation. The species was recently also reported from British Columbia (Noble et al. 1989; as Phragmonevia fuckelii Rehm)

Lichenicolous fungus new to Alberta.

Specimen examined: Canada: Alberta, Kananaskis Provincial Park, Highwood Pass 50°35'N, 115°00' W, Goffinet C90.4.120-b (PMAE - under P. rufescens - duplicate herb. B. Goffinet and herb. P. Diederich)

Diploschistes diacapsis (Ach.) Lumbsch

This specimen was collected in "eroding banks of short grass prairie banks" and initially identified as Diploschistes scruposus (Schreber) Norman. The latter, however, has an epruinose thallus and is restricted to acidic habitats where it is saxicolous (versus a terricolous habit of the calcicolous D. diacapsis). The specimen reported here represents the northernmost occurrence of this species over its world range (see map in Lumbsch 1989).

Lichen new to Canada.

Specimen examined: Canada: Alberta, Brooks area, Dinosaur Provincial Park, Vitt 12020 (ALTA).

Diploschistes muscorum (Scop.) R. Sant.

The discovery of this species in Alberta is not surprising as it known from British Columbia, Manitoba and Saskatchewan (Lumbsch, 1989). All specimens collected in Alberta are intimately associated with Cladonia thalli, revealing the fact that the mycobiont of this Diploschistes is an obligate parasite, at least in the early establishment stages. The genus Diploschistes is represented by three species in Alberta. Diploschistes muscorum differs from the two others, D. diacapsis and D. scruposus, by its asci invariably containing four spores and its parasitic habit during the early stages of the life cycle.

Lichen new to Alberta.

Specimens examined: Canada: Alberta, Badlands of Red Deer River valley, Hanna, July 1937 (ALTA); Drumheller, Midland Provincial Park, 51°28'N, 112°42'W, Goffinet 1815 (herb. Goffinet, duplicate PMAE); Medecine Hat area, Dinosaur Provincial Park, Horton 1296 (ALTA); Banff National Park, Panther River, 52°30'N, 117°40'W, J.E. Marsh JE8107 (ALTA); Banff National Park, Upper Dormer, J.E. Marsh JE8134; Brooks area, Dinosaur Provincial Park, Vitt 12035(ALTA).

Illosporium carneum Fr.

In North America this lichenicolous hyphomycete was previously known only from Ontario (Hawksworth 1979; Brodo 14628 & 14716 with Fabiszewski - CANL 27920 & 27916) and from Newfoundland (Ahti 5831 - CANL 75155, Brodo pers. com.). Its discovery in Alberta and British Columbia (Goward et al. in prep.) confirms Hawksworth's assumption that it is more widespread in North America.

Lichenicolous fungus new to Alberta.

Specimen examined: Canada: Alberta, Jasper National Park, Wabasso, Ostafichuk 274-6 (ALTA - under Peltigera didactyla - duplicate herb. Paul Diederich)

Lobaria hallii (Tuck.) Zahlbr.

This euoceanic species endemic to North America is only known from the western part of the continent, from California to Alaska. It also occurs in Idaho and Montana but in Canada L. hallii was only collected in coastal British Columbia (Jordan 1973). The specimen reported here from Alberta appears to be the most northern continental locality. It was collected in a forest with Picea glauca, Pinus contorta and Shepherdia canadensis.

The genus Lobaria is represented with certainty by two other species in Alberta: L. linita (Ach.) Rabenh. and L. pulmonaria (L.) Hoffm.; both can easily be segregated from L. hallii by their green photobiont (see also under next species). Lobaria hallii is closely related to the rather cosmopolitan L. scrobiculata (Scop.) DC., but differs by the presence of a marginal tomentum on the upper surface and the absence of stictic acid in the medulla (Jordan 1973; chemistry confirmed here, see below).

Lichen new to Alberta.

Specimen examined: Canada: Alberta, Jasper National Park, Fiddle River trail, 53°07'N, 117°46'W, Marsh 1838 (ALTA; chemistry - solvent G: no lichen substances detected).

Lobaria oregana (Tuck.) Müll. Arg.

This species, a western North-American endemic, was reported by Vitt et al. (1989) as disjunct between the Pacific Coast and the Rocky Mountains. The chemistry of two specimens collected in the eastern slope of the Rockies (Marsh 1833 and Scott 8014, ALTA) was analysed and revealed that they represent immature forms of L. pulmonaria (L.) Hoffm. In the absence of other collections from that area, it appears that L. oregana is actually restricted to the coast and the wet interior, as was already suggested by Jordan (1973). The most continental locality known at present is a site in Idaho (Schroeder & Melquist L2070, ALTA)

Lichen to be deleted from the Albertan flora.

Nephroma isidiosum (Nyl.) Gyelnik

In North America, Nephroma isidiosum is only known west of the Rocky Mountains, from British Columbia and Alaska (Noble et al. 1989; Wetmore 1960). The discovery of a specimen of this euoceanic species among collections made by Pegg in the Grande Cache area is of great interest as it represents a significant eastward range extension and the most continental locality in western Canada. The specimen was collected on a rock outcrop in "shady poplar, pine, spruce woods". Nephroma isidiosum is somewhat similar to certain forms of N. parile (Ach.) Ach. and N. helveticum Ach. but can be distinguished from the former by its isidia and the tomentose lower surface and from the latter by the lack of pubescens and scabrosities on the upper cortex. The chemistry of Pegg's collection is well in agreement with that of specimens from British Columbia (Vitt 18699 & Marsh 1729; ALTA) with regards to its major secondary metabolites and these three collections all lack the hopane triterpenoid 7ß-acetoxyhopan-22-ol (peltidactylin - T1) occasionally reported from European material (James & White 1987).

Though the species was considered to be rare in North America (Wetmore 1960 and Thomson 1984) N. isidiosum has recently been collected in nearly a dozen localities in British Columbia where the species appears to be a good indicator of old-growth forests (Goward pers. com.).

Lichen new to Alberta

Specimen examined: Canada: Alberta, Grande Cache, 53°53'N, 119°05' W, 3 Aug. 1970, Pegg 3761 (ALTA, PMAE, LG: C89.2.521; chemistry (ALTA & LG)- solvent C & G: methyl gyrophorate; gyrophoric acid; hopane-7ß,22-diol [T4]; two unidentified triterpenoids below T5 and T6 respectively, a UV + pigment identical to that found in N. helveticum, see James & White, 1987).

Pronectria erythrinella (Nyl.) Lowen

This lichenicolous fungus develops apparently exclusively on species of Peltigera (Lowen pers. com.). No earlier report of this fungus was found for Canada; however, the species is known from two other localities of cool temperate Alberta and British Columbia (Lowen, pers. com.). The specimen cited here was collected in a willow dominated, burned area, were it grew on Peltigera didactyla (With.) Laundon

Lichenicolous fungus new to Alberta.

Specimens examined: Canada: Alberta, Cypress Hills, Hormack 95 (ALTA - under Peltigera didactyla - duplicate herb. Paul Diederich).

Acknowledgments. I am particularly grateful to Drs. I. Brodo (CANL), P. Diederich (LUX), T. Lumbsch (ESS) for helping in various ways with the identification of Nephroma isidiosum and lichenicolous fungi. Dr. R. Lowen (NY) and T. Goward (UBC) generously commented on the North-American distribution of P. erythrinella and Nephroma isidiosum, respectively. A critical review by Dr. I. Brodo and Dr. R. Harris (NY) of an earlier version of the manuscript was greatly appreciated. The continuous support and encouragement from Drs. E. Sérusiaux (LG) and D. Vitt (ALTA) was always appreciated. Dr. E. Sérusiaux and I. Cremasco (LG) kindly confirmed the chemistry of N. isidiosum. This study was made possible by a NSERC-operational grant to Dale Vitt (ALTA).

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Botryosphaeria cocogena nov. sp. Agent causal du dessèchement foliaire du cocotier au Brésil

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Résumé:

La "Queima das folhas", maladie foliaire des cocotiers au Brésil, est attribuée généralement au *Botryodiplodia theobromae* et à son téléomorphe le *Botryosphaeria rhodina.* L'étude réalisée sur le terrain dans une plantation industrielle de cocotiers au Para (Brésil) a permis d'isoler à partir des lésions foliaires, le champignon responsable de la "Queima das folhas". L'étude morphologique, les caractères culturaux, les inoculations artificielles ainsi que les activités isoenzymatiques de cet isolat ont été comparés à ceux de *Botryosphaeria rhodina* ou de *Botryodiplodia theobromae.* Il ressort que l'Ascomycète récemment isolé est très différent du *Botryosphaeria rhodina.* Nous proposons donc d'en faire une nouvelle espèce que nous nommons: *Botryosphaeria cocogena.*

Mots clés: Queima das folhas, leaf blight, *Botryosphaeria rhodina, Botryodiplodia theobromae, Botryosphaeria cocogena.*

Summary:

The leaf blight of coconut palms in Brazil ("Queima das folhas") is commonly attributed to the fungus *Botryodiplodia theobromae* and its teleomorph, *Botryosphaeria rhodina.* In a plantation in Brasilian amazonia, we have isolated the fungus responsible of the disease "Queima das folhas". This fungus is very different from all strains of the fungus *Botryosphaeria theobromae* or *Botryosphaeria rhodina*, we received from culture collections: description of the stromata, cultures, enzymatic activities are distinct. The artificial inoculations indicate that *Botryosphaeria rhodina* and *Botryodiplodia theobromae* are weak pathogens on coconut palms. For all these reasons, we propose to consider the fungus responsible of "Queima das folhas" as a new species: *Botryosphaeria cocogena.*

Resumo:

A "Queima das folhas", doença foliar do coqueiro brasileiro é atribuida geralmente ao fungo *Botryodiplodia theobromae* e ao teleomorfo, *Botryosphaeria rhodina.* A pesquisa de campo realizada em uma plantaçao industrial de coqueiros (Para, Brasil) permitiu-nos de isolar o fungo causador da "Queima das folhas". Os resultados morfologicos, as caracteristicas culturais, as inoculaçoes artificiais, as atividades isoenzimaticas deste fungo foram comparados as *Botryosphaeria rhodina* e de *Botryodiplodia theobromae* das micotecas. Mostramos que o Ascomiceto da "Queima das folhas" parece muito diferente do *Botryosphaeria rhodina* e por isso, propomos a consideraçao do fungo causador da "Queimas das folhas" como uma nova especie que denominamos: *Botryosphaeria cocogena.*

Au cours de la décennie écoulée, une maladie foliaire provoquant le dessèchement des feuilles des cocotiers s'est développée au Brésil. Cette maladie, appelée localement "Queima das folhas" correspond à un "leaf blight" (Warwick et al. 1991). Les symptômes furent attribués au *Botryodiplodia theobromae* puisque seule la forme conidienne avait été observée (Franco 1975, Souza filho et al. 1979, Warwick et al. 1991). Nos travaux menés dans une plantation industrielle de cocotiers sur la commune de Moju dans l'état du Para au Brésil ont révélé la présence simultanée de la forme sexuée ou téléomorphe et de la forme asexuée du pathogène (Subileau et al. 1990).

Le *Botryodiplodia theobromae* Pat. considéré comme un *Lasiodiplodia theobromae* par Zambettakis (1954) est classiquement associé à la forme sexuée *Botryosphaeria rhodina* (Cooke) Von Arx (Stevens 1926, Voorhes 1942, Alvarez Garcia 1968) décrite elle aussi comme pathogène de nombreux hôtes dont le cocotier. Le *Botryosphaeria rhodina* a déjà été isolé sur cocotier et conservé en mycothèque mais aucune description n'a été réalisée sur cet hôte.

Les formes sexuée et asexuée associées observées dans cette plantation, peuvent elles être rapportées au *Botryosphaeria rhodina*? Telle est la question posée.

Au terme d'une recherche épidémiologique accompagnée d'isolements, de cultures *in vitro*, de réinoculations sur feuilles de cocotiers et d'études isoenzymatiques, nous avons pû comparer les caractères culturaux, la morphologie des fructifications et des spores ainsi que les pouvoirs pathogènes des différentes espèces impliquées en vue de préciser la position taxonomique de notre isolat.

MATERIEL ET METHODES

Souches utilisées

Les souches mycéliennes utilisées proviennent d'isolements monospores réalisées par micromanipulation à partir d'ascospores et de conidies d'échantillons récoltés sur des cocotiers de plantation industrielle de la région de Moju. A titre de comparaison, nous avons sélectionné des souches de mycothèque de *Botryodiplodia theobromae* Pat. (IMI 100347; IMI 100351) et de *Botryosphaeria rhodina* (Berkeley et Curtis) Von Arx (CBS 30658). Les souches de *Botryosphaeria theobromae* proviennent d'isolements de lésions foliaires sur cocotier au Sri Lanka. Celle de *Botryosphaeria rhodina* est issue du *Cocos nucifera* L. sans autre précision. Deux autres souches de *Botryosphaeria rhodina* sur *Persea americana* (MUCL 28171) et *Cassava* (MUCL 6642) ont été également étudiées dans ce travail.

Hôte utilisé

Les cocotiers utilisés sont des hybrides sélectionnés PB 111 (Nain Rouge du Cameroun x Grand Ouest Africain) obtenus à partir de culture d'embryon axénique sur milieu nutritif.

Inoculation

Les différentes souches ont été inoculées sous forme de fragments mycéliens déposés sur un limbe de foliole de cocotier. Ces fragments ont été également utilisés comme inoculum pour la culture de ce champignon sur milieu hôte. Ce milieu est constitué de fragments de folioles de cocotier (1g) autoclavés en présence d'eau distillée (20 ml).

Révélations enzymatiques

Après 7 jours de culture des différentes souches sur milieu synthétique gélosé (Dehorter 1985) recouvert d'un disque de cellophane, le mycélium (60 mg/ échantillon) est broyé à 4°C en présence de tampon tris-Glycine (4,95 mM, pH=8,3) avec 0,17% de mercaptoéthanol, de PVP (polyvinyl pyrrolidone), de saccharose, de sable de Fontainebleau ainsi que du bleu de Bromophénol indiquant le front du solvant. Le broyat est ensuite centrifugé à 25000g et l'extrait composé du surnageant est conservé à 4°C. La séparation des protéines spécifiques a été réalisée par électrophorèse verticale sur gel d'acrylamide. Les activités enzymatiques retenues pour notre matériel sont: les estérases (EST), les phosphatases acides (Pho-A), la malate deshydrogenase (ME) et l'isocitrate deshydrogenase (IDH).

RESULTATS

Symptômatologie

Sur les feuilles, les symptômes se caractérisent par de grandes taches nécrotiques internervaires de coloration marron clair, arrondies, délimitées par une zone marginale de coloration jaunâtre et visibles sur les deux faces de la foliole (photo 1). En vieillissant, les taches prennent une coloration grisâtre à brun grisâtre dûe au dessèchement totale de cette zone. Il existe, mais de manière moins fréquente, un symptôme dit en "V" (Anomyne 1992), qui démarre à l'extrémité des feuilles et évolue en direction du rachis. Ces lésions s'accompagnent parfois d'un exsudat gommeux.

Les lésions foliaires sont au début de petite taille: 0,5 à 1 cm de diamètre mais peuvent atteindre en plein développement 30 à 40 cm de long. Souvent, en grandissant, elles s'accolent les unes aux autres et finissent alors par occuper la totalité de la feuille. Le dessèchement évolue en envahissant ensuite le rachis de la feuille.

Les feuilles ainsi atteintes, brunissent puis noircissent, se dessèchent, se cassent et finissent par pendre le long du stipe. Les attaques provoquent de nombreux dégats essentiellement sur la moitié inférieure du feuillage. Des lésions sur les fruits (noix) sont apparues depuis 1990 mais ne semblent pas se propager sur cet organe.

Au sein des lésions et sur la face supérieure du limbe, les fructifications du champignon apparaissent sous forme de petites ponctuations noires, bombées, bien visibles à la loupe binoculaire. Elles sont isolées le plus souvent et font légèrement saillies au stade adulte.

Description

Botryosphaeria cocogena sp. nov.

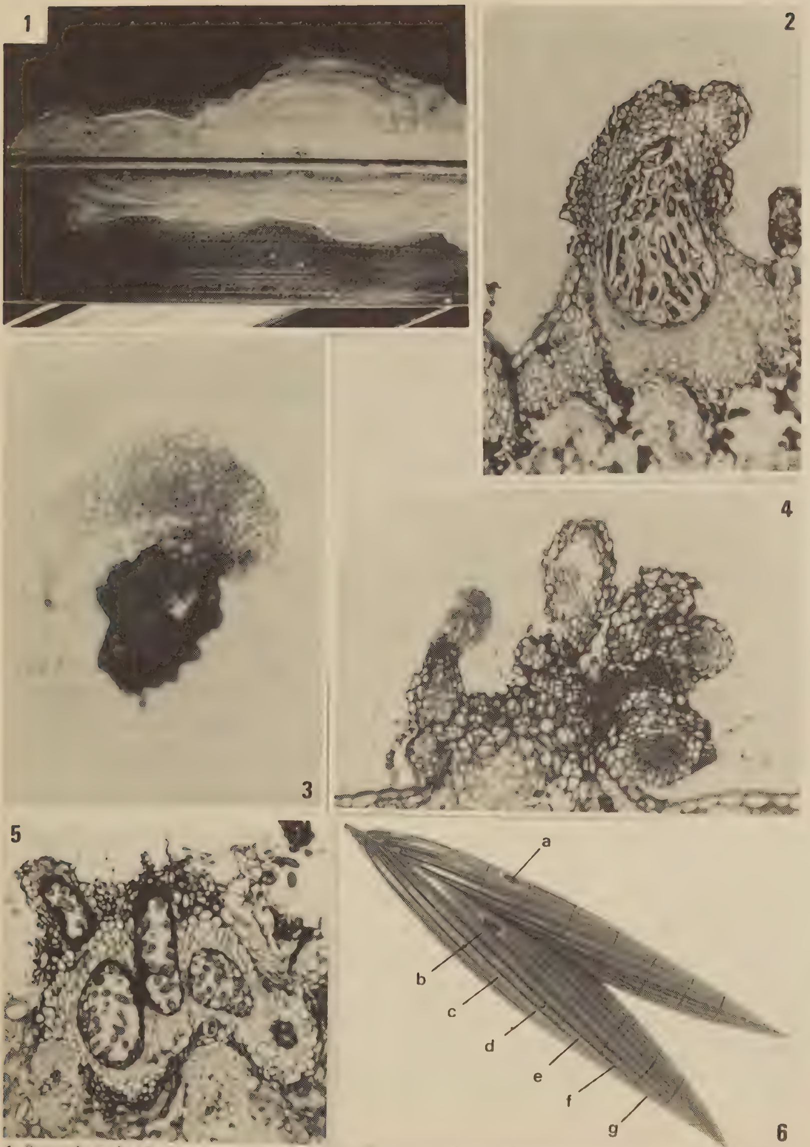
Maculis praesentibus; Stromatibus parenchymatosis in superiore latere foliae, pars perithecia alii pycnidia continentibus.

Asci clavatis, pedicellatis, 8-sporis, non paraphysatis, bitunicis, distichis, 140-150 x 24-28 µm; Ascosporis ovoideo-fusiformibus latere anguloso, hyalinis, unicellularibus, involutis mucosis, 26-30 x 11-15 µm; Spermogoniis figuratis excrescentes stromatosa et continentibus spermatia 2-3 x 0,5-1 µm.

Conidiis hyalinis, unicellularibus, fusiformibus, truncato apice, involutis mucosis, 21-27 x 8-12 µm in Sphaeropsi similibus pycnidis.

In foliis Cocos nuciferae (Moju, Para, Brésil, Subileau 1993, typus in herb. PC N°1; vivens cultura in coll PC n° 93 3675 deposito)

Les ***périthèces*** se développent au sein de lésions déjà en voie de dessèchement. Ils sont visibles extérieurement sous forme de renflements de l'épiderme. Ils sont isolés et uniloculaires de forme ovoïde et présentant le plus long diamètre dans le sens de la nervure; leur taille varie de 1 à 3 mm. Ils contiennent des asques avec nasse apicale à différents stades de développement entourés d'un tissu stromatique plus ou moins lysé, sans paraphyse (photo 2). Les *asques* sont bituniqués et contiennent huit ascospores distiches leur conférant une forme en massue. Leur taille est de 140-150 x 24-28 µm (fig. 1). Les *ascospores* sont fusiformes à ovoïdes, asymétriques anguleuses d'un seul coté. Elles sont hyalines, unicellulaires, guttulées, dotées d'une gaine mucilagineuse excepté aux deux extrémités. Leur taille est de 26-30 x 11-15 µm (fig. 2).



1. Symptôme de "Queima das folhas"sur foliole do cocotier. **2.** Périthèce de *Botryosphaeria cocogena* in coupe. **3.** Spermaties de *Botryosphaeria cocogena* en coupe. **4.** Spermogonie de *Botryosphaeria cocogena* en coupe. **5.** Pycnide de *Botryosphaeria cocogena* en coupe. **6.** Inoculation artificielle sur cocotier des *Botryosphaeria* étudiés: **a.** Souche monoascosporée de "Queima das folhas" Cocos nucifera **b.** Souche monoconidienne de "Queima das folhas" Cocos nucifera **c.** Botryosphaeria rhodina (MUCL 28171) Persea americana **d.** Botryosphaeria rhodina (MUCL 6642) Cassava **e.** Botryosphaeria rhodina (CBS 30658) Cocos nucifera **f.** Botryodiplodia theobromae (CMI 100351) Cocos nucifera **g.** Botryodiplodia theobromae (CMI 100347) Cocos nucifera

Les ***spermogonies*** se développent à la surface du tissu stromatique sur hôte et sur milieu hôte sous forme d'excroissances de petite taille. Leur existence est très fugace. Elles émettent des microspores (*spermaties*) hyalines unicellulaires amylacées de 2 à 3 sur 0,5 à 1 µm (photo 3). La structure de ces conceptacles n'a pû être étudiée en coupe cytologique que sur des cultures *in vitro* (photo 4). Les microspores n'ont pas germé malgré de nombreuses tentatives. Elles se comportent comme des spermaties et les structures qui les produisent seraient donc des spermogonies.

Les ***pycnides*** (photo 5), premiers conceptacles formés au cours du processus de dessèchement de la feuille, ont la même structure stromatique que les périthèces bien que souvent de plus grande taille (2 à 5 mm de diamètre). Nées sur des phialides courtes et trapues et entourées de paraphyses hyalines renflées à leur extrémité, les *conidies* sont hyalines, unicellulaires, symétriques, de taille égale à 21-27 x 8-12 µm, entourées d'un très fin mucilage (fig. 3).

Caractères morphologiques distinctifs

Selon la bibliographie et l'étude des souches (Stevens 1936, Voorhes 1942, Alvarez-Garcia 1968), le *Botryosphaeria rhodina* a de nombreux caractères morphologiques en commun avec le *Botryosphaeria cocogena*: la taille, la forme des asques et des ascospores ainsi que leur couleur. Néammoins, il n'est jamais fait mention de microspores chez le *Botryosphaeria rhodina.*

La forme asexuée du *Botryosphaeria rhodina,* le *Botryodiplodia theobromae* produit des conidies généralement brunes, rarement hyalines (état immature). Elles sont le plus souvent septées, bicellulaires, caractérisées par des bandes longitudinales pigmentées donnant l'effet de striation contrairement au *Botryosphaeria cocogena* dont les conidies sont hyalines et unicellulaires sans striations longitudinales même à maturité. Le stade asexué du champignon impliqué dans la "Queima das folhas" ne correspond pas au *Botryodiplodia theobromae.* Il s'apparente au *Sphaeropsis* (Sacc.), genre regroupant les anamorphes de certains *Botryosphaeria* tels que le *B. laricis, B. obtusa, B. visci.*

Caractères culturaux distinctifs

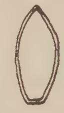
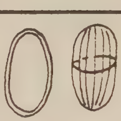
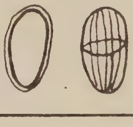
L'aspect des cultures des souches étudiées a été comparé sur milieu synthétique (Dehorter 1985) et résumé dans le tableau 1. Les souches ascosporées et conidiennes du *Botryospheria cocogena* diffèrent du *Botryosphaeria rhodina* et du *Botryodiplodia theobromae* par un mycélium gris noir faiblement aérien, par la croissance du mycélium et la production des stromas nettement plus lentes, par la production de conidies plus grandes, plus étroites, toujours hyalines à complète maturité.

Tableau 1: Aspects culturaux sur milieu synthétique des champignons étudiés

	Botryosphaeria cocogena	**Botryosphaeria rhodina**	**Botryodiplodia theobromae**
Mycélium			
couleur	gris/noir	gris clair	gris clair
aspect	ras	très aérien	très aérien
Temps de production des stromas	8 jours	5 jours	5 jours
Taille des conidies (en µm)			
longueur	21/27	17/21	17/23
largeur	8/12	9/13	9/13
% de conidies hyalines	100%	0%	0%

L'aspect cultural observé également sur milieu hôte, seul milieu permettant d'obtenir régulièrement la forme sexuée du *Botryosphaeria cocogena*, est reporté dans le tableau 2. Le *Botryosphaeria cocogena* diffère des deux autres souches par le temps d'apparition des divers stromas, la taille et la forme des conidies, la présence de conidies brunes et septées.

Tableau 2: Aspects culturaux sur milieu cocotier des champignons étudiés

	Botryosphaeria cocogena	**Botryosphaeria rhodina**	**Botryodiplodia theobromae**
CONIDIE Temps d'apparition	10 jours	6 jours	8 jours
Taille (en µm) longueur	25/30	21/25	21/26
largeur	8/12	14/16	14/17
% de conidies hyalines	100%	0%	0%
forme			
ASCOSPORE Temps d'apparition	28 jours	-	-
Taille (en µm) longueur	26/30	-	-
largeur	11/15	-	-
SPERMOGONIE présence	oui	non	non

Inoculation artificielle

Après scarification légère de la cuticule des feuilles de jeunes cocotiers, des fragments mycéliens des différentes souches ont été mis en contact avec le limbe blessé. Des lésions de même aspect et de même taille ont été produites par les souches asexuées et sexuées du champignon étudié. Le *Botryosphaeria cocogena* est donc très pathogène sur cocotier. Par contre dans les mêmes conditions, toutes les autres souches testées de *Botryosphaeria rhodina* et de *Botryodiplodia theobromae* n'ont pas donné de symptômes (Photo 6). Ces souches de mycothèques étant anciennes, on peut certes mettre en question le maintien du pouvoir pathogène.

Dans les mêmes conditions, l'inoculation du *Botryosphaeria cocogena* sur canne à sucre, bananier et manguier n'a produit aucune lésion sur les feuilles ce qui met en évidence une spécificité d'hôte de ce champignon pour le cocotier. De même, sur les milieux hôte composés de feuilles de canne à sucre, bananier, manguier, cet Ascomycète a certes produit des stromas restés stériles tandis que le milieu hôte cocotier permet sa reproduction sexuée et asexuée. Le *Botryosphaeria cocogena* se comporte donc comme un pathogène spécifique du cocotier.

Etude électrophorétique de l'activité isoenzymatique

L'étude isoenzymatique a porté sur les souches conidiennes et ascosporées du *Botryosphaeria cocogena* mais également sur les souches de mycothèque (fig. 4). Les souches des huit ascospores de deux asques et les cinq souches conidiennes isolées sur cocotier ont été testées et les profils enzymatiques se sont révélés homogènes. Il y a donc pas de variabilité entre chacune de ces souches, aussi nous ne présentons que l'étude enzymatique d'une souche ascosporée et d'une souche conidienne. Les extraits des deux cultures de cet Ascomycète présentent des profils électrophorètiques identiques, quel que soit le système enzymatique utilisé et sont très différents des profils de *Botryosphaeria rhodina*. Par contre, les souches de *Botryosphaeria rhodina* (CBS 30658, MUCL 28171, MUCL 6642) et de *Botryodiplodia theobromae* (IMI 100347, IMI 100351) ont des révélations enzymatiques identiques entre elles, ceci va dans le sens de la relation anamorphe-téléomorphe qu'on leur attribue. Par ailleurs, les profils des souches de *Botryosphaeria rhodina* sont identiques bien que ces souches ne soient pas issues du même hôte. Les souches du champignon impliqué dans la "Queima das folhas" n'appartiennent donc pas, au vu des résultats enzymatiques, à l'espèce *Botryosphaeria rhodina* et à son anamorphe.

CONCLUSIONS

Sur la base des résultats obtenus à la fois sur la morphologie, la culture des souches, les inoculations artificielles et l'étude isoenzymatique, nous pouvons tirer les conclusions suivantes:

1) L'existence d'une forme sexuée chez l'agent responsable de la "Queima das Folhas" citée dans les rapports CIRAD-IRHO (Anonyme 1992) est confirmée dans ce travail. Les souches isolées à partir d'une ascospore ou d'une conidie de l'Ascomycète isolé sur cocotier ont le même comportement.

De plus, les inoculations artificielles et la culture sur milieu hôte ont clairement montré que la forme asexuée est organiquement associée à la forme sexuée trouvée sur les mêmes folioles. Ce sont donc bien les deux formes de reproduction du même champignon.

2) Les souches isolées de *Botryosphaeria cocogena* sur cocotier sont différentes des souches de *Botryosphaeria rhodina* et de *Botryodiplodia theobromae,* son anamorphe. Dans la littérature, il est certes fait mention du *Botryodiplodia theobromae* et *Botryosphaeria rhodina* sur *Cocos nucifera* mais sans description. Néammoins la connection entre la forme sexuée (*Botryosphaeria rhodina*) et la forme asexuée (*Botryodiplodia theobromae*) est confirmée par l'analyse isoenzymatique et par la production de conidies de *Botryodiplodia* à partir de culture de *Botryosphaeria rhodina.* Le champignon décrit ici ne correspond donc pas au *Botryosphaeria rhodina.*

3) Le *Botryosphaeria cocogena* isolé dans l'état du Para au Brésil est extrêmement spécifique du cocotier. Or, aucune espèce de *Botryosphaeria* n'a été décrite sur *Cocos nucifera* L.. En conclusion, l'Ascomycète responsable de la "Queima das Folhas" et isolé sur cocotier en Amazonie Brésilienne peut être considéré comme une nouvelle espèce.

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A Study of Morphological Variability, Character Analysis, and Taxonomic Significance in the Zygomycetous Anamorph-Genus *Umbelopsis*.

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SUMMARY

Umbelopsis nana displays great morphological variability in its reproductive structures. Although 26 of 35 known different morphologies were characterised in the present study, relatively few of these appeared to be diagnostic. This raises intriguing questions concerning the establishment of ground rules for taxonomic concepts in fungi, and for the process of identification.

INTRODUCTION

The generic name *Umbelopsis* was introduced by Amos and Barnett (1966) for the single species, *U. versiformis* Amos & Barnett. The original authors considered it to be a hyphomycetous dikaryomycotan anamorph. Von Arx (1982) decided that it was a member of the Zygomycota and tentatively transferred it to the family Mucoraceae (order Mucorales, class Zygomycetes), but he also suggested that it might be better placed in the family Thamnidiaceae of the same order. We do not find either of these familial dispositions appropriate. *Umbelopsis versiformis* has not been reported to form zygosporangia, and its single-spored sporangia are never columellate. All members of the Mucoraceae have large, multispored sporangia with well-defined columellae (Benny, 1982; Hesseltine and Ellis, 1973; Turner, 1963). Evidence is now being accumulated for the zygomycetous affinity of *Umbelopsis* (Gams, pers. comm.). We consider that if the zygomycetous nature of the fungus is established, it would be most appropriately placed in the Mortierellaceae, since members of this family do not produce columellate sporangia. Benny (pers. comm.) concurs. In the intervening years, several species have been added to the genus, and *Mortierella nana* Linnemann and *U. versiformis* are now considered synonyms of *U. nana* (Linnemann) von Arx. However, the focus of this paper is neither taxonomic disposition or nomenclatural status, but rather analysis of morphologic characters.

Amos and Barnett chose the specific epithet *versiformis* "to describe the many different forms of conidiophores [sporangiophores] produced." We have recently re-isolated this fungus in pure culture, and were struck by the same variability. This raises several questions. If the organism is so variable, on what stable cohort of characters can the taxon be based? Does the published concept express the full spectrum of diversity exhibited by the fungus? And if it does, could such a broad definition be so vague as to result in the assignment of very dissimilar forms to the same taxon, or to create overlap with other existing taxa? How much of the range of form must be seen before the taxon can be identified? What bearing does all this have on the broader concepts of fungal taxonomy?

As part of the preliminaries to constructing a large computer database for identification of anamorphic fungi, the Waterloo group is undertaking a detailed character analysis of conidial anamorphs. This study involves a level of analytical description, documentation, and integration of data not previously attempted for the entire group. The rationale behind this analysis is as follows. The classification of anamorphic fungi is still based very largely on morphological features. It remains a matter of convenience, rather than being based on true relationships rooted in phylogeny (since that phylogeny remains obscure). Accordingly, we are striving to make the record of morphological information as precise and as full as possible. When our compilation is complete, the computer database embodying the results of the analysis should permit rapid, synoptic identification of fungal anamorphs (Kendrick, 1990). This database will: (a) include all known genera; (b) standardize terminology; (c) include comprehensive analysis of all features. It will also permit better correlation of anamorph with teleomorph than is now possible.

Umbelopsis nana is an organism whose inherent variability will allow us to test some of the concepts underlying the database and, it is hoped, refine the ways in which we analyze, select and record variation for the computer.

MATERIALS AND METHODS

The *Umbelopsis nana* isolate appeared when attempts were made to culture a *Peziza* sp. Pieces of the *Peziza* ascoma approximately 1 cm^2 were surface sterilized in 30% H_2O_2 for 20 to 30 sec then placed on modified Melin-Norkrans (Marx, 1969) agar plates. Four days after inoculation *Umbelopsis* was identified in the culture and was subcultured in slide cultures following the method of Stevens (1974). The *Peziza* fruited in a soil bioassay study conducted in the Oregon State University greenhouses. The soil in the pots was obtained from young managed forests (12-year-old *Pseudotsuga menziesii* (Mirb.) Franco plantations) from the Oregon Coast Range, Mapleton Ranger District, Siuslaw National Forest (Sect. 26, T. 18 S., R.#9 W.). The soil bioassay was set up in June, 1990, and the *Peziza* was harvested from the pots in October, 1990. A voucher specimen of the *Peziza* is NSW 6381 and has been deposited at OSC. Character analysis and morphological variation quantification of *Umbelopsis nana* were derived from random observations of 490 sporulating structures taken from 9 slides. Photomicrographs of the sporulating structures were taken to determine and quantify the full range of variation.

RESULTS

Umbelopsis is an organism with relatively simple reproductive morphology. Its most complex reproductive structures incorporate a combination of only four morphological elements. These may be described qualitatively as follows.

(1) **Sporangiophores**: short lateral branches arising perpendicularly from assimilative (somatic) hyphae.
(2) **Vesicles**: apical swellings at the apex of sporangiophores, or sessile on hyphae, or intercalary in hyphae.
(3) **Pedicels**: more or less straight, slender, slightly tapering sporangium-bearing extensions, arising individually from the upper part of the vesicle, or directly from hyphae.
(4) **Sporangiola**: spherical, one-spored mitosporangia borne singly at the apex of each pedicel.

Variation enters the picture in many ways. For ease of reference in describing it, we will use the numbering system just introduced.

(1) Sporangiophores — these do not vary significantly in width, although their length can vary considerably (by a factor of about 3). Sporangiophores may also be absent (i.e., the other three reproductive structures may develop directly from an assimilative hypha). For our analysis we have recognized four conditions:
    (a) sporangiophore axis long (Fig. 1A, D);
    (b) sporangiophore axis medium (Fig. 1B);
    (c) sporangiophore axis short (Fig. 1C);
    (d) sporangiophore axis absent (Fig. 1E-H).
(2) Vesicles — there is never more than one vesicle, and this does not vary significantly in its dimensions, but it may occur in different positions, or may be absent:
    (a) vesicle at apex of sporangiophore (Fig. 1A-C);
    (b) vesicle sessile on somatic hypha (Fig. 1E);
    (c) vesicle intercalary, appearing as a swelling of a somatic hypha (Fig. 1G, H);
    (d) vesicle absent (Fig. 1D, F).
(3) Pedicels — these do not vary significantly in their dimensions and proportions, but they may arise in different positions:
    (a) pedicels arising from a vesicle at the apex of a

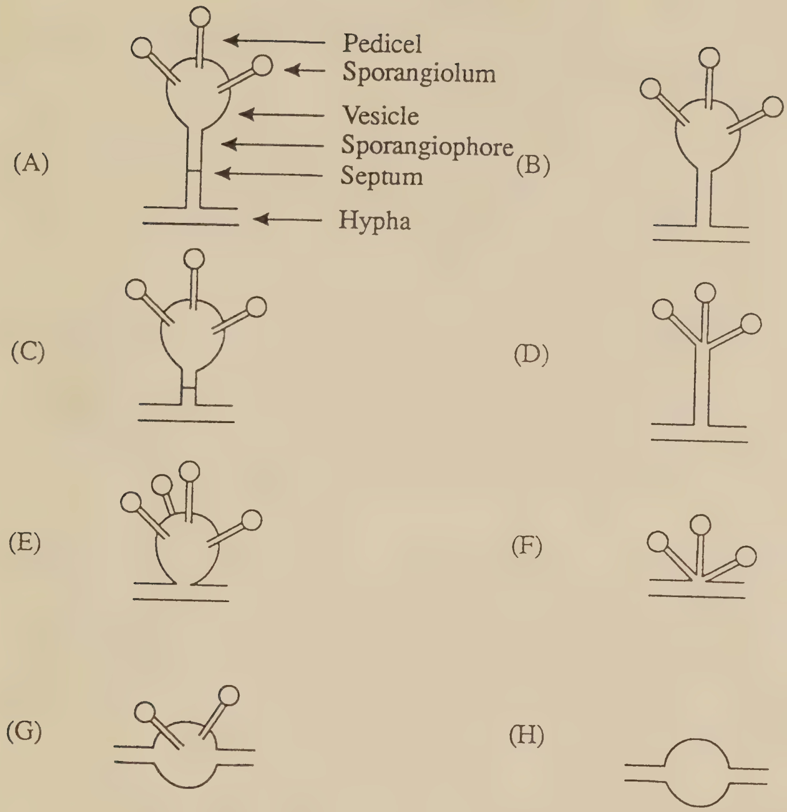

(A)
Pedicel
Sporangiolum
Vesicle
Sporangiophore
Septum
Hypha
(B)
(C)
(D)
(E)
(F)
(G)
(H)

Fig. 1. A-H. Morphological variability in *Umbelopsis nana*. (A)-(C) sporangiophores of different length with vesicle, pedicels, and sporangiola present. (D) vesicle absent with sporangiophore, pedicels, and sporangiola present. (E) sessile vesicle with pedicels and sporangiola present. (F) sporangiophore and vesicle absent with pedicels and sporangiola present. (G) vesicle intercalary with pedicels and sporangiola present. (H) vesicle intercalary with pedicels and sporangiola absent.

sporangiophore (Fig. 1A-C);
(number of pedicels ranges from 1-6);

(b) pedicels arising from a sessile or intercalary vesicle (Figs. 1E, G);
(number of pedicels ranges from 1-7);

(c) pedicels arising at the apex of an unswollen hypha (sporangiophore) (Fig. 1D);
(number of pedicels ranges from 1-8);

(d) pedicels arising laterally from a somatic hypha (Fig. 1F);
(number ranges from 1-5);

(e) pedicels absent (Fig. 1H).

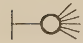
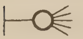
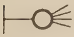
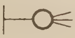
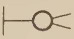
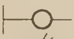
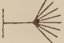
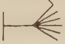
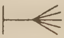
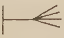
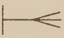
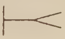
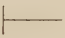
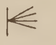
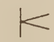
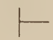
(4) Sporangiola on individual pedicels do not vary significantly in their number, shape or dimensions: there is always one sporangiolum at the apex of each pedicel; sporangiola are always spherical. Their diameter ranges from 4.5-7.5 µm, but the smaller ones may well be immature, thus exaggerating the variation that exists in mature sporangiola.

Drawings in Fig. 1 are representative of the principal morphological variations observed in *Umbelopsis nana*. "Stick drawings", mimicking the sporulating structures, derived from the slide cultures and photomicrographs are illustrated in Table 1. We have considered sessile and intercalary vesicles to represent a single category, because in some instances it was difficult to differentiate the two. The percentages are derived from observations of 490 randomly chosen sporulating structures.

The terminology adopted for Table 1 is that which is being used in constructing the database. Each distinguishable feature of a fungus is assigned a unique three-letter code. (One-letter codes permit only 26 different codes; two-letter codes permit 26 x 26 = 676 codes; three-letter codes permit 26 x 26 x 26 = 17,576 codes. This is surely ample to describe all fungal features, even allowing for the fact that codes should be recognizable as having been derived from the name of the feature, e.g. SPH = sporangiophore, VES = vesicle, PCL = pedicel, and that some letter combinations will be unusable "nonsense" triads such as XWQ). The three-letter codes speed up both the initial entry of data into the computer, and the subsequent entry of search data.

The unique three-letter code prefaces each piece of data describing the feature, as in: SPHpresent = sporangiophore present, VESabsent = vesicle

Table 1.

Description of combination of features	Illustration	Percentage of total sporulating structures
(1) SPHpresent VESpresent PCL6		1.2
(2) SPHpresent VESpresent PCL5		2.2
(3) SPHpresent VESpresent PCL4		3.3
(4) SPHpresent VESpresent PCL4		5.7
(5) SPHpresent VESpresent PCL2		3.1
(6) SPHpresent VESpresent PCL1		0.6
(7) SPHpresent VESabsent PCL8		0.2
(8) SPHpresent VESabsent PCL6		0.2
(9) SPHpresent VESabsent PCL5		1.4
(10) SPHpresent VESabsent PCL4		2.9
(11) SPHpresent VESabsent PCL3		4.3
(12) SPHpresent VESabsent PCL2		5.1
(13) SPHpresent VESabsent PCL1		6.5
(14) SPHabsent VESpresent PCL7		0.2
(15) SPHabsent VESpresent PCL6		1.2
(16) SPHabsent VESpresent PCL5		2.9
(17) SPHabsent VESpresent PCL4		6.1
(18) SPHabsent VESpresent PCL3		6.7
(19) SPHabsent VESpresent PCL2		7.3
(20) SPHabsent VESpresent PCL1		5.7
(21) SPHabsent VESpresent PCL0		3.7
(22) SPHabsent VESabsent PCL5		0.4
(23) SPHabsent VESabsent PCL4		2.0
(24) SPHabsent VESabsent PCL3		5.1
(25) SPHabsent VESabsent PCL2		8.8
(26) SPHabsent VESabsent PCL1		13.0

absent, PCL3 = pedicels three in number. If a feature has a number of sub-features, a fourth letter can be added to specify these, as when we need to express, in addition to the number of pedicels (PCLN), the number of septa in each pedicel (PCLS), the length of each pedicel (PCLL), the angle at which pedicels diverge (PCLA), etc. Moreover, certain quantitative features could be divided into arbitrary ranges, such as SPHlong, SPHmedium and SPHshort, terms which could be applied to Figs. 1A, 1B and 1C, respectively. For this study we employed SPHpresent, SPHabsent, VESpresent, VESabsent, and PCLn (where n is the number of pedicels, ranging from 1 to 8). This shorthand simplifies Table 1 without causing the kind of loss of information that could threaten the validity of our study. Although some sporangiophores are 1-septate and others are not, we have not treated this as a significant variation, since it does not appear to be correlated with their length or any significant differences in external morphology. In addition, since there was little significant variation in some features, such as width of sporangiophores, dimensions of pedicels, and shape and dimensions of sporangiola, we omitted any consideration of their size or variability. We note that there is an unvarying 1:1 ratio between pedicels and sporangiola. So, despite the fact that our organism is variable, that variability is restricted to a small number of features. This in turn generates a manageable amount of data.

Amos and Barnett gave several clear line drawings, in which they illustrated five combinations from among the above set (here reproduced as Fig. 2A-E). The characteristic codes for each of these drawings are given in the legends.

DISCUSSION

A consideration of Table 1 permits some conclusions to be drawn, both about variability in *Umbelopsis nana*, and about the nature of the process of identification.

The spread of data among the 26 categories we observed bears out our initial impression that *U. nana* is a rather variable organism. Unfortunately, since the variation expressed by other anamorphs has not yet been analyzed in the same way, we cannot say how much more variable this taxon is than the average. We note that the structure shown in Fig. 2E (redrawn from Amos and Barnett, 1966) is not included in the 26 categories we encountered (Table 1), since we did not observe a vesicle bearing 8 pedicels. Amos and

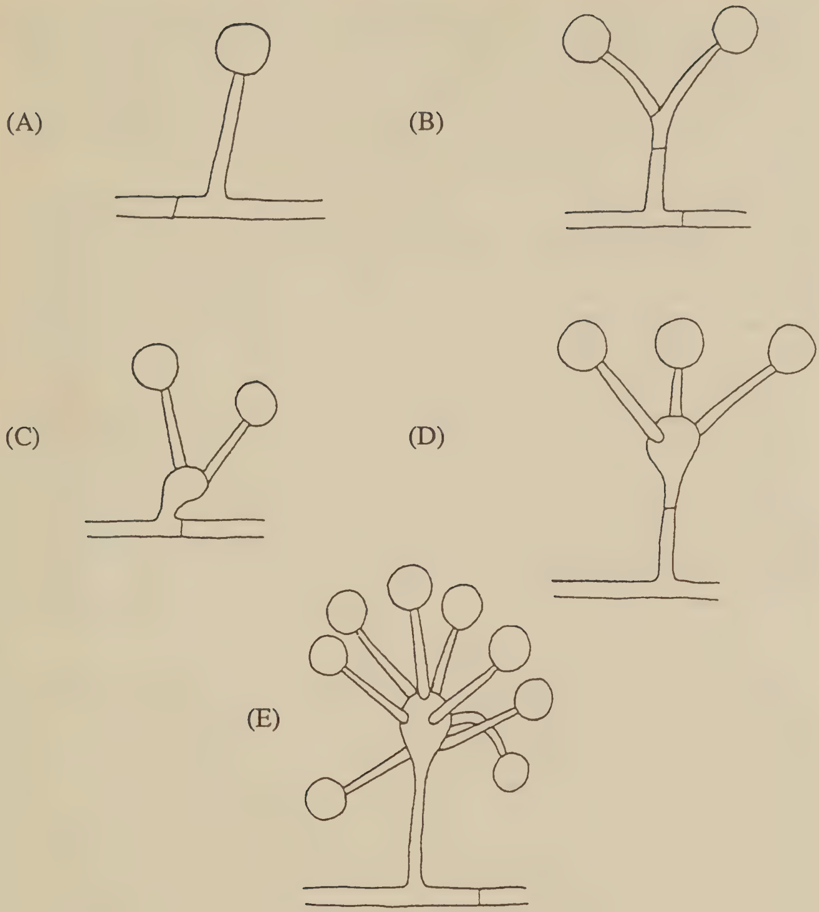


Fig. 2. A-E. Different morphologies of *Umbelopsis nana*. Taken from Amos and Barnett, 1966. All X 510. (A) Simple pedicel with single sporangiolum. (SPHabsent VESabsent **PCL1**) (B) Branched sporangiophore with 2 pedicels and sporangiola. (**SPHpresent** VESabsent **PCL2**) (C) Sessile vesicle produced directly on somatic hypha. (SPHabsent **VESpresent PCL2**) (D) Sporangiophore with vesicle and 3 pedicels. (**SPHpresent VESpresent PCL3**) (E) Typical sporangiophore bearing 8 pedicels and sporangiola. (**SPHpresent VESpresent PCL8**)

Barnett stated that as many as 14 pedicels arose from a single stipitate vesicle. This means that the full expression of variability, as observed by Amos and Barnett, was divisible into 35 categories (i.e. our 26 categories plus 8 others for stalked vesicles with 7 to 14 pedicels, plus one we did not see — sporangiophore lacking a vesicle, but bearing 7 pedicels — that nevertheless fell within the range covered by our observations).

When we look at the features of *U. nana* in terms of the ease with which it may be identified, or discriminated from other similar organisms, we can draw some interesting conclusions. The first, concerning the diagnostic structure of *Umbelopsis*, is that all four major features must be present concurrently as part of a single sporulating structure before all conditions for recognition of the taxon are met. The minimal diagnostic structure in *U. nana* would combine a sporangiophore, vesicle, and at least two pedicels bearing sporangiola. We feel that illustration 6 from Table 1 (i.e. combination of sporangiophore, vesicle, and 1 pedicel bearing a sporangiolum), though far from the simplest manifestation of the taxon, is not adequate to identify the species. It is difficult, when examining the fungus through a microscope, to decide whether a single sporangiolum is truly a sporangiolum and not something else, and whether the vesicle is intercalary or sessile. Our second conclusion, after carefully examining and comparing all 26 categories shown in Table 1, is that a significant proportion of the sporulating structures must fall into the first five categories if the organism is to be correctly identified. As it happens, only 16% of the sporulating structures fell into those classes. The fact that only one in six of the reproductive structures in this species is diagnostic raises some important questions. It is usual for generic concepts to be based on the most abundant reproductive structure. Yet in this case, that is one without a vesicle and sporangiophore and with only one pedicel (illustration 26). It may be thought surprising that the genus cannot be identified by reference to the reproductive structure it produces most abundantly. The reason for this is that the commonest structure is too simple: it does not present as much diagnostic information as do the more complex morphs. A similar emphasis on the more complex structures produced by a fungus has been previously employed elsewhere in the taxonomic literature. Among the best-known examples is the application of the principle of Hochkultur to *Fusarium* (Appel & Wollenweber, 1910).

Even so, all but one of the variations have at least one pedicel with a sporangiolum, the exception being sessile and intercalary vesicles lacking pedicels. The pedicels and sporangiola are always uniform in size and shape, and can therefore be considered for the role of diagnostic or conservative features in *Umbelopsis nana.* We feel confident that they would be rejected if any alternative existed, because of their at least superficially simple structure which is not rich in taxonomically useful information. Fortunately, alternatives do exist. One possibility is to ignore the simpler structures and focus exclusively on the more complex ones (e.g. categories 1-5 in Table 1). This calls upon the identifier to ignore much of the extant variability: to be selective in visual analysis. Such an approach is well known to mycologists, who in examining slide preparations of their organisms, must learn to deal with many situations in which there is a very low "signal to noise" ratio.

Another valid possibility, but one not widely used in taxonomy (for obvious reasons), is to recognize the inherent variability of *Umbelopsis nana* as diagnostic in itself. This would explicitly require the detection and recording of a high percentage of the 35 known combinations before a positive identification could be made. The question of what percentage would be required has no intuitively correct answer, and might require some advanced statistical tests for its resolution.

It is intriguing that all the different morphologies of *Umbelopsis nana* develop intermixed under the same environmental conditions. What is the evolutionary significance of this degree of phenotypic plasticity? It seems to denote a certain lack of selection pressure in the environmental conditions under which the organism has been grown, both by Amos and Barnett and by ourselves. It is entirely possible that on certain natural substrates, or under specific conditions, this apparently ill-defined taxon will produce a much narrower range of sporulating structures and become more clearly delineated. However, we have no direct evidence for that. The taxonomic decision may be based on the variable morphology and not on energy or nutrient requirements, even though the variability could be a function of available nutrient resources, rather than of genetic expression. From the taxonomist's point of view, such evident plasticity provides a challenge, and may promote description of the organism under different and confusing names.

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CONOPLEA EUCALYPTI sp. nov. FROM INDIA

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ABSTRACT

A new species of dematiaceous hyphomycete, *Conoplea eucalypti* collected from leaf litter of *Eucalyptus longifolia* in South India, is described and illustrated.

Some new and interesting Hyphomycetes have already been described from *Eucalyptus* leaf litter in South India (Dorai & Vittal, 1984, 1987 a, b, 1988, Vittal & Dorai, 1986, 1991) and this contribution is a continuation of these studies.

Conoplea eucalypti sp. nov. (Fig. 1 & Pl. 1)

Coloniae dispersae, brunneae, in laminis foliis pulvinatae. *Mycelium* exparte superficiale, ex parte immersum, stromatibus pulvinis in quae conidiophora producentibus. *Conidiophora* ramosa, recta, usque ad 300 μm longa, ad basim 5-7 μm lata, apicem versus pallescentia et tenuitunicata quae sumus 3-4 μm lata; conidiophora composita e stipitibus

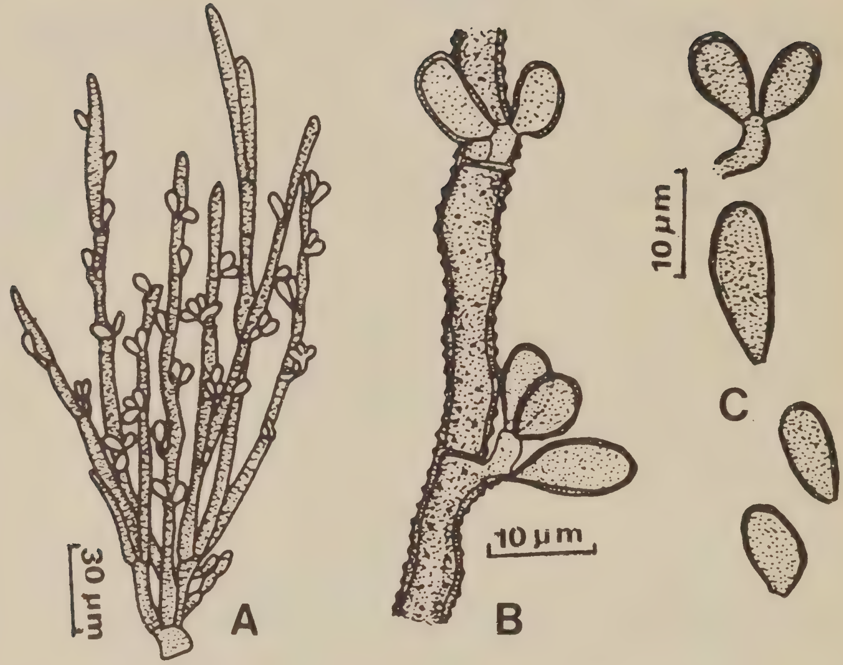

Fig.1 A. Habit, B. Conidiophore, Conidiogenous ells and developing conidia, C. Conidia

principalibus, e ramorum primariorum et secundariorum praedita cellulae conidiogenae. *Cellulae conidiogenae* erectae crebre appressae versus ramos conidiophoros. *Conidia* producta e ramulis conidiogenis fecundatis apicis ex stipitum primariorum et apicis ramorum, lateellipsoidea vel clavata, pallide brunnea, laevia, unicellularia, absque germ-rimis, 6-12 x 4-5 μm.

In foliis putridis *Eucalypti longifoliae*, Ananthagiri (Andhra Pradesh), India leg. M. Dorai, March 1987, Herb. MUBL No. 3078, holotypus.

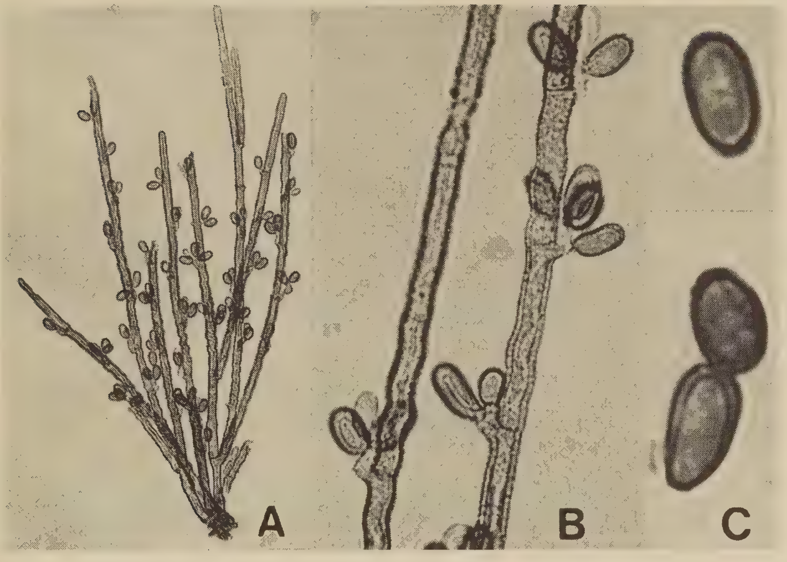

Plate 1. A. Habit (X 300); B. Conidiophores (X 1000); C. Conidia (X 2000)

Colonies scattered, brown, pulvinate on the lamina of the leaf. *Mycelium* partly superficial, partly immersed, with pulvinate stromata on which conidiophores are produced. *Conidiophores* branched, straight, up to 300 μm long, 5-7 μm wide below, paler and thinner-walled towards the apex which is 3-4 μm wide, composed of a main stalk and primary and secondary branches bearing conidiogenous cells; *Conidiogenous cells* upwardly directed, often closely adpressed to the branch that bears them. *Conidia* are produced on the conidiogenous branchlets and on the fertile ends of the main stalk and its branches, broadly ellipsoidal to clavate, pale brown, smooth-walled, 1-celled, without a germ slit, 6-12 x 4-5 μm.

This species resembles *C. geniculata* (Corda) Hughes (Hughes, 1960) in the morphology of conidiophores which are not helically twisted and also in producing conidia on definite conidiogenous branchlets. However, it differs from *C. geniculata* in the morphology of these branchlets which show some resemblance to those seen in *C. fusca* Pers. The new species differs from both the above species in the absence of separating cells and germ pores.

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ADDITIONAL NOTES TO THE LICHEN GENUS SCHISMATOMMA (ARTHONIALES)

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Summary: Through an unfortunate oversight four taxa, *Schismatomma ricasolii, S. pitardi, S. hafellneri*, and *Enterographa pseudorufescens*, all treated by Torrente & Egea (1989) were left unnoticed by me in my monograph "The genus *Schismatomma* (Arthoniales)" (Tehler 1993).

These taxa are to be treated as the following:

Schismatomma ricasolii (Massal.) Torrente & Egea as a dubious name.

Schismatomma hafellneri Torrente & Egea as temporarily belonging to the genus *Schismatomma.*

Schismatomma pitardi (B. de Lesd.) Torrente & Egea as a taxonomical synonym to *S. albocinctum* (Nyl.) Zahlbr.

Enterographa pseudorufescens (B. de Lesd.) Redinger as a taxonomical synonym to *Schismatomma graphidioides* (Leight.) Zahlbr.

Schismatomma ricasolii (Massal.) Torrente & Egea

Torrente & Egea 1989: 222; basionym: *Lecanactis ricasolii* Massalongo 1852: 53. - *Type*: Vive sui tronchi degli Alberi nella Toscana (not seen!).

Material studied by me: "Opegrapha Ricasoli, Hb. Lich Schaerer, Garoveglio in litt." (G). "Opegrapha Ricasolii Gar. ex Etrusia Dr. C. Ricasoli" in Hb Massalongo (VER).

Torrente & Egea (1989) argues that this name has priority over *Schismatomma graphidioides* (Leight.) Zahlbr. [basionym: *Chiodecton graphidioides* Leighton 1854: 395]. The type material studied by Torrente & Egea (1989) is cited as isotype with a question mark. According to them the material is located in Munich (M) but no such material seems to be present (Hertel pers. comm.). In any case, the material cited by (Torrente & Egea 1989) cannot be the type because it is not cited in the protologue by Massalongo (1852). I have studied other, tentative type material collected by Ricasoli, originally determined as *Opegrapha ricasolii,* from Massalongo´s type herbarium in Verona (VER) and from the herbarium in Geneva (G). *Schismatomma graphidioides* were present in both collections but other species were present as well on the small pieces of bark.

There are two major problems with the name *Lecanactis ricasolii.*

Firstly, none of the collections above as well as the material cited by Torrente & Egea (1989) can be referred to as type material because the only locality cited by Massalongo (1852) is "Vive sui tronchi degli Alberi nella Toscana".

Secondly, Massalongo´s (1852) protologue of *Lecanactis ricasolii* is not in accordance with that of *Schismatomma graphidioides* as it should be if synonymized. The first part of Massalongo´s description is held in a general form and could fit any of the species present in the Ricasoli collections cited above. However, a striking exception in the protologue of *Lecanactis ricasolii* is the characterization of the ascospores which are described as 8-10 celled (Massalongo 1852) as opposed to spores of *Schismatomma graphidioides* which are 4-celled. It is very unlikely that such spores are confused and evidently the spores described for *Lecanactis ricasolii* relate to another, yet unidentified species that was described by Massalongo (1852). It should be noted though that I have not found such spores in any of the other species present on the Ricasoli collections above.

Under the circumstances referred to above, it should be clear that the name *Lecanactis ricasolii* must remain dubious until the type material is traced and the questions concerning Massalongo´s original description are resolved.

Schismatomma hafellneri Torrente & Egea

Torrente & Egea 1989: 211. - *Type*: Spain, Canary Islands, Tenerife, Güímar, 3 km al norte de Arafo, CS 6136, 450 m.s.m., en una pared basáltica supervertical orientada al N. 1984, Llimona & Egea 13561 (MUB, holotype).

There are phylogenetic evidence suggesting that *Schismatomma hafellneri* together with some species formerly lumped in the genus *Schismatomma* as well as some species presently referred to the genus *Roccellina* are better placed in a new genus (Tehler in prep., see also Tehler 1993; 1994).

Schismatomma pitardi (B. de Lesd.) Torrente & Egea

Torrente & Egea 1989: 219; basionym: *Opegrapha pitardi* Bouly de Lesdain 1913: 162. - *Type*: Morocco, Tanger, sur le *Pinus pinea*, 1911, Pitard s.n. (PC, lectotype).

Schismatomma pitardi is taxonomically synonymous to the earlier described *Schismatomma albocinctum* (Nyl.) Zahlbr. 1924: 553, [basionym: *Opegrapha albocincta* Nylander 1854: 335], see Tehler (1993).

Enterographa pseudorufescens (B. de Lesd.) Redinger

Redinger 1938: 70; basionym: *Opegrapha pseudorufescens* Bouly de Lesdain 1906: 78. - *Type*: France, Herault, La Salvetat, bois d´Arifat sur un Houx, 1905, Marc s.n. (PC, lectotype).

Enterographa pseudorufescens is taxonomically synonymous to *S. graphidioides* (Leight.) Zahlbr. 1924: 557, [basionym: *Chiodecton graphidioides* Leighton 1854: 395], see Tehler (1993) for further synonomy on the latter name.

Remarks. In this context it should be noted that Torrente & Egea (1989) erroneously uses the name *Schismatomma abietinum* instead of the correct name *Schismatomma pericleum* (Ach.) Deichmann Branth (Tehler 1986; 1993). Furthermore, Torrente & Egea (1989) incorrectly uses the name *Schismatomma picconianum* instead of the correct name *S. dirinellum* (Tehler 1993).

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MYCOTAXON

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NEORAMULARIA CAPPARIDIS SPEC. NOV.

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Neoramularia capparidis spec. nov. Fig. 1

Leaf spots amphigenous, small, greyish-white, with narrow brown margin, mycelium internal, subhyaline, forming large substomatal to intraepidermal stromata, ca. 50-70 µm diam., subcircular to elliptic in outline, pale olivaceous to yellowish brown. Conidiophores in very rich, dense fascicles, arising from stromata, straight and subcylindric to moderately geniculate-sinuous, ca. 10-20 x 1-3 µm, simple, aseptate, colourless, smooth, conidial scars inconspicuous, unthickened, not darkened. Conidia solitary or in short chains, subcylindrical (-ellipsoid) to narrowly obclavate, rarely fusiform, ca. 10-32 x 1.5-3 µm, 0-3-septate, colourless, smooth, apex and base subacute, rounded to truncate, hila unthickened, not darkened.

Maculae amphigenae, minutae, griseo-albidae, margine tenui atrobrunnea cinctae. Mycelium immersum: hyphae subhyalinae. Stromata substomatalia vel intraepidermalia, ca. 50-70 µm diam., dilute olivacea vel flavido-brunnea. Conidiophora dense fasciculata, numerosa, recta, subcylindrica vel modice geniculata-sinuosa, ca. 10-20 x 1-3 µm, simplicia, non septata, subhyalina, laevia. Cicatrices conidiales inconspicuae, non incrassatae, incolores. Conidia solitaria vel catenulata, subcylindrica (-ellipsoidea) vel anguste obclavata (-fusiformia), ca. 10-32 x 1.5-3 µm, 0-3 septata, subhyalina, apice et basi subacuta, rotundata vel truncata, hila non incrassata, incoloria.

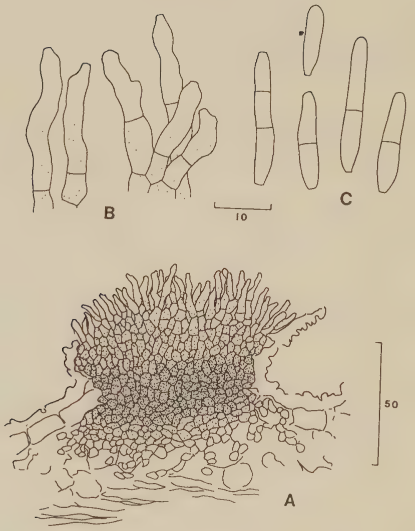

Fig. 1: *Neoramularia capparidis* spec. nov., A - conidioma, B - conidiophores, C - conidia. B. C. Sutton del.

Holotypus: on *Capparis spinosa* L. (Capparaceae), India, Hyderabad (A.P.), VIII. 1989, G. Bagyanarayana (IMI 355015).

Paratypus: on *Capparis spinosa* L., India, Hyderabad (A.P.), I. 1990, G. Bagyanarayana (IMI 355016).

The present species is well characterized by colourless conidiophores in rich and dense fascicles, inconspicuous, unthickened conidial scars and hyaline conidia, often formed in short chains. These features agree with Braun's (1991, 1992) concept of *Neoramularia*. The stromata in *N. capparidis* are faintly pigmented, but conidiophores and conidia are colourless. Faintly coloured stromata are also known in *Ramularia* (e.g. *R. jaapiana* (Magn.) U. Braun = *R. statices* Rostr., cf. Braun, 1993) and *Pseudocercosporella* (e.g. *P. eryngii* (West.) U. Braun, 1993).

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MISCELLANEOUS NOTES ON PHYTOPATHOGENIC HYPHOMYCETES

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Summary: The present paper contains descriptions of 13 new phytopathogenic hyphomycetes, viz. the new taxa *Passalora oenotherae*, *Pseudocercosporella ranunculacearum*, *P. tonellae*, *Ramularia antennariicola*, *R. cylindroides* var. *angustispora*, *R. eriogoni*, *R. eriophylli*, *R. exigua*, *R. ligusticicola*, *R. phlogis*, *R. sanguisorbicola*, *R. tecta* and *Stigmina dispori*. The new genera *Episporogoniella* (type species: *Didymaria muscigena* Speg.) and *Rhexocercosporidium* (type species: *Acrothecium carotae* Årsvoll) are included. Nineteen new combinations, two new redescriptions and revisions of some species are added.

(1) ***Cercospora phaseolina ("faseolina")*** Speg., An. Soc. cient. Argent. 13, p. 28 (1882) - Fig. 1.

Holotypus: on *Phaseolus ovatus* Benth. (Fabaceae), Argentina, Buenos Aires, Palermo, 15-5-1881, Spegazzini (LPS 912).

Chupp (1954) suggested that this species does not belong to *Cercospora*. According to the type material, *C. phaseolina* is, however, a true *Cercospora* in the sense of Deighton (1976), obviously distinct from the common *C. canescens* by much shorter conidia with few septa and, above all, obconically truncate bases.

This species is characterized as follows: Leaf spots subcircular to somewhat irregular, pale ochraceous to brown, ca. 1-4 μm diam., with narrow dark brown margin or marginal line. Conidiophores fasciculate, arising from small brown stromata (a few swollen brown hyphae), straight, subcylindrical to somewhat geniculate (especially in the upper half, about 50-80 x 3-5 μm, brown, mostly septate, conidial scars thickened and darkened. Conidia solitary, acicular (-subcylindric, obclavate), 20-60 x 3-5 μm, 1-5-septate, hyaline, apex rounded to subacute, base obconically truncate, hila slightly thickened and darkened.

(2) ***Cercospora stomatophila*** (Speg.) U. Braun **comb. nov.**
- Fig 2.

Basiomym: *Cercosporella stomatophila* Speg., An. Soc. cient. Argent. 26(1), p. 69 (1888).

Holotypus: on a Sapindaceous host (cf. *Allophyllus* spec.), Paraguay, Guapi, Sept. 1883, Balansa 4086 (LPS 12506).

Leaf spots amphigenous, subcircular to irregular, ca. 0.5-3 mm diam., pale yellowish-ochraceous, brownish, finally greyish-white, with narrow, often somewhat raised margin. Caespituli hypophyllous. Conidiophores in small, loose fascicles, arising from brown, pseudoparenchymatous, substomatal stromata (up to 60 µm diam.), simple, ca. 10-40 x 3-4 µm, straight, subcylindrical to somewhat geniculate, continuous to septate, at first subhyaline, later pale olivaceous to yellowish-brown, conidial scars minute, but conspicuously thickened and darkened. Conidia solitary, acicular-fusiform (-subcylindrical), ca. 20-30 x 1.5-2.5 µm, 1-3-septate, hyaline, apex acute, base truncate, hila slightly thickened and darkened.

This species is a typical *Cercospora* with coloured conidiophores, thickened, darkened conidial scars and hyaline, acicular conidia. It is well characterized by small conidia with few septa. The identity of the host plant was checked. The leaves very probably belong to *Allophyllus* sp.

(3) ***Cercospora valerianae*** (Siemaszko) U. Braun **comb. nov.**
- Fig. 3.

Basionym: *Cercosporella valerianae* Siemaszko, Izv. Kavk. Mus. 12, p. 27 (1919).

Holotypus: on *Valeriana sambucifolia* Mik. f. (Valerianaceae), Abchasia, Caucasus, Ckho, herb. Siemaszko (WA).

Additional material examined: on *Valeriana sitchensis* Bong., USA, Mt. Rainier Nat. Park, Wash., 27-7-1959, Shaw (WSP 49492).

Leaf spots amphigenous, subcircular to angular-irregular, ca. 2-8 mm diam., pale, greenish, yellowish-ochraceous, greyish-white, margin indefinite. Caespituli amphigenous, greyish-white, loose to dense, punctiform. Mycelium internal, subhyaline, branched, stromata absent, sometimes small hyphal aggregations, intraepidermal. Conidiophores solitary or in small fascicles, erumpent through the cuticle, 5-25 x 3-6 µm, simple, conical, slightly geniculate-sinuous, subhyaline, later often very pale yellowish-greenish, olivaceous or yellowish-brown, conidial scars thickened and darkened. Conidia solitary, acicular-obclavate, 40-130 x 4-6 (-7) µm, hyaline, 1-5-, mostly 3-4-septate, apex subacute, base

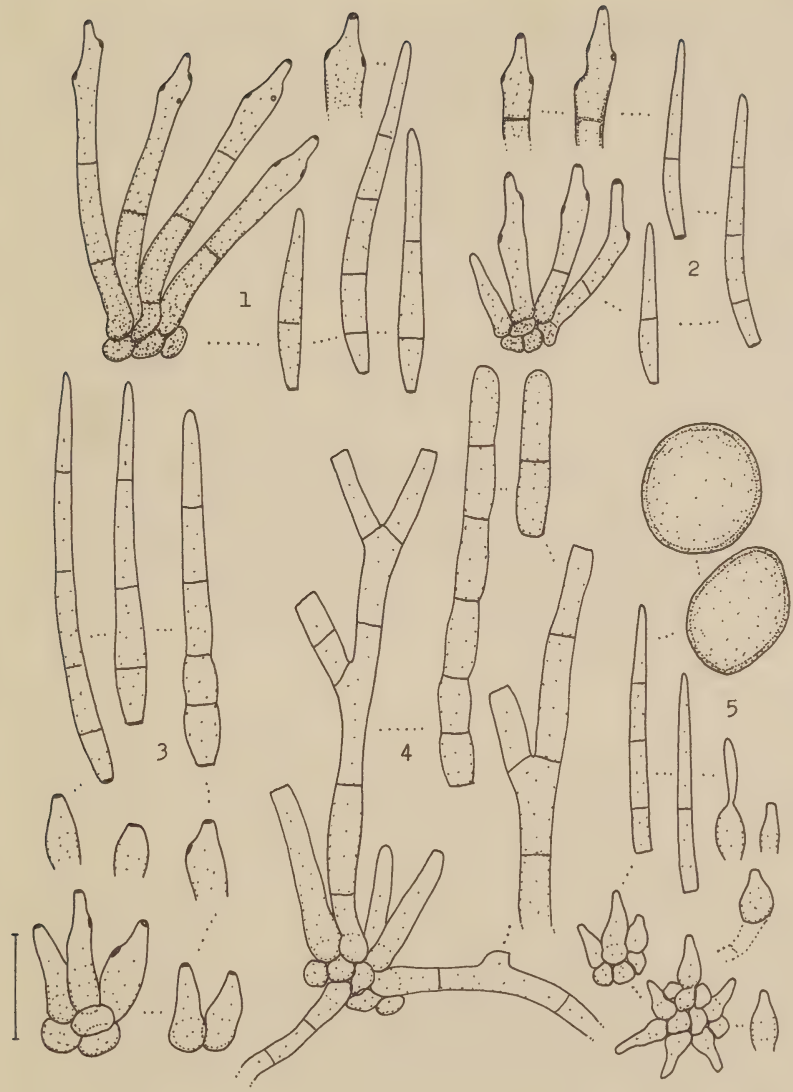

Fig. 1-5: Conidiophores, fascicles, conidia, spores [5] of (1) *Cercospora phaseolina*, (2) *C. stomatophila*, (3) *C. valerianae*, (4) *Cylindrocladiopsis hurae*, (5) "*Entyloma gaillardiae*" with anamorph. Scale 20 µm. U. Braun del.

truncate, hila slightly thickened and darkened.

The present species belongs to *Cercospora* subgen. *Hyalocercospora* Braun (1993a), characterized by hyaline or subhyaline conidiophores. The conidial scars are thickened and darkened and do not coincide with *Cercosporella* scars.

(4) ***Cylindrocladiopsis hurae*** (Linder & Whetzel) U. Braun **comb. nov.** - Fig. 4.

Basionym: *Cercosporella hurae* Linder & Whetzel, in Linder, Mycologia 29, p. 656 (1937).

Lectotypus: on *Hura crepitans* L. (Euphorbiaceae), Venezuela, Valencia Lake, 28-6-1932, Chardon 363 (CUP). Isolectotypus: FH.

C. hurae is closely allied to *Cylindrocladiopsis lagerstroemiae* Yen (1979). *Cylindrocladiopsis* is well characterized by long, erect, frequently dichotomously branched conidiophores, cylindrical conidiogenous cells, holoblastic (monoblastic), with flat, broad, unthickened conidial scars. The conidia are formed singly or in short, disarticulating chains. Superficial creeping hyphae are present. All structures are colourless (fig. 4). The conidial scars and conidial formation remind of *Thedgonia*.

Full description and illustration: Linder (Mycologia 29, pp. 656-658, fig. A-B).

(5) Anamorph of "*Entyloma gaillardiae* (Speg.) Speg."

Material examined: on *Gaillardia aristata* Pursh (Asteraceae), USA, Wash., Yakima River banks, Benton Co., 18-8-1902, Cotton (WSP 43592), sub *Ramularia* spec.

This material contains immersed, large, *Entyloma*-like spores (subglobose, 20-35 µm diam., wall smooth, 1-2 µm wide, subhyaline to yellowish), agreeing with Spegazzini's (1909, p. 284) description of *Protomyces* ? *gaillardiae*. Spegazzini (l.c.) himself presumed that these structures could be oospores of a downy mildew. Later, he transferred this species to *Entyloma* (Spegazzini 1925, p. 148). Vánky (1985, p. 69) examined type material of this species, but failed to find any spores agreeing with the original description.

The large, *Entyloma*-like spores in the North American sample are associated with an anamorph: Mycelium internal, hyphae septate, 1.5-7 µm wide, hyaline or subhyaline, smooth, forming small pseudoparenchymatous hyphal aggregations; conidiogenous cells solitary or in small groups, arising from inner hyphae or hyphal aggregations, erumpent through the cuticle, subglobose, conical, ampulliform, subcylindrical, usually 5-12 x 4-5 µm, hyaline, smooth, aseptate, monoblastic; apices (conidial scars) usually truncate after conidial liberation, neither thickened nor darkened, conidia formed singly, acicular, 20-60 x 3-4 µm, 0-3-septate, hyaline, smooth, apex acute, base truncate, hila unthickened. Fig. 5.

The generic affinity of this anamorph is unclear. It is quite distinct from *Entylomella*. There is no appropriate genus for this fungus. Because of this very unusual conidial state, it is very doubtful that "*Protomyces ? gaillardiae*" belongs to *Entyloma*. Its affinity of is a mystery. For the time being it must provisionally be deposited under "*Entyloma gaillardiae*" (with anamorph).

(6) *Episporogoniella* U. Braun **gen. nov.**

Fungi imperfecti, Hyphomycetes. Muscicola (sporogoniicola). Mycelium immersum vel superficiale: hyphae subhyalinae, laeves, septatae, interdum ramosae. Conidiophora mononematosa, macronematosa, ex hyphis aggregatis oriunda, solitaria vel caespitosa, erecta vel decumbentia, longiuscula, lata, subcylindrica, subhyalina, laevia, septata, interdum ad septa constricta. Cellulae conidiogenae integratae, terminales, monoblasticae, determinatae, subcylindricae. Cicatrices conidiales truncatae, latae, non incrassatae. Conidia solitaria, subcylindrica, subclavata, longiuscula, septata, subhyalina, laevia, ad apicem rotundata, basi truncata, non incrassata.

Type species: *Didymaria muscigena* Speg. (= *Episporogoniella muscigena* (Speg.) U. Braun)

Fungi imperfecti, Hyphomycetes. Muscicolous (sporogoniicolous). Mycelium internal aa well as external, superficial, loosely aggregated, subhyaline, smooth, septate, occasionally branched. Conidiophores mononematous, macronematous, arising from hyphal aggregations, solitary or loosely caespitose, erect or decumbent, long, fairly broad, subcylindrical, subhyaline (faintly yellowish-greenish), smooth, septate, occasionally constricted at the septa, conidiogenous cells integrated, terminal, monoblastic, determinate, subcylindrical, conidial scars truncate, broad, unthickened. Conidia solitary, subcylindrical, subclavate, septate, subhyaline (very pale yellowish-greenish), smooth, apex rounded, base truncate, hila unthickened.

Episporogoniella muscigena (Speg.) U. Braun **comb. nov.** - Fig. 6.

Basionym: *Didymaria muscigena* Speg., Boln. nac. Cienc. Córdoba 11(4), p. 613 (1889).

Holotypus: on sporogonia of *Rhynchostegium* spec. (Bryophyta, Brachytheciaceae), Brazil, Apaihy, 1880, J. Puiggari (LPS 12764).

Sporogoniicolous (on capsules), mycelium immersed and erumpent, superficial, forming loose, irregular layers of aggregated hyphae and swollen cells, subhyaline, septate, sparsely branched, smooth, about 3-12 µm wide. Conidiophores arising from hyphal aggregations, solitary or loosely caespitose, erect or decumbent, subcylindric, ca. 50-250 x 6-14 µm, simple, subhyaline (pale yellowish-greenish), septate, occasionally with constrictions, smooth, conidiogenous cells integrated, terminal, monoblastic, determinate, conidial scars truncate, unthickened, not darkened. Conidia solitary, subcylindrical (-subclavate), ca. 30-150 x 7-14 µm, subhyaline (faintly yellowish-greenish), 1-6-septate, frequently 1-septate, smooth, apex rounded, base truncate, unthickened.

The published length of the "conidiophores" undoubtedly comprises measurements of conidiophores as well as conidiophores with still attached conidia. The differentiation between both types is difficult.

The present species is a very specific fungus, confined to sporangia of *Rhynchostegium*. *Episporogoniella* is allied to *Sporidesmium* s.str. (emend. Subramanian 1992), but differs in having hyaline or subhyaline conidiophores and conidia and monoblastic, determinate conidiogenous cells (frequently percurrent in *Sporidesmium*). *D. muscigena* is included in Racovitza's (1959) paper on bryophilous fungi, but his description is a only a French translation of the original diagnosis.

Braun (1993b) referred ***Septocylindrium olivascens*** Thüm. to *Sporidesmium*, which belongs to *Sporidesmium* s.str. (ss. Subramanian, l.c.), although the conidiophores are frequently nodulose. The swellings are, however, caused by constrictions of true septa and are not connected with the conidiogenesis and proliferation of conidiogenous cells. Hence, this species should not be placed in *Penzigomyces* Subramanian (l.c.). The conidiogenous cells in *S. olivascens* are monoblastic, determinate to irregularly percurrent (not strictly determinate, cf. Braun, l.c.). Fig. 7.

(7) ***Eriomycopsis guaranitica*** (Speg.) U. Braun **comb. nov.** - Fig. 8.

Bas.: *Cercosporella guaranitica* Speg., An. Soc. cient. Argent. 26(1), p. 69 (1888).

Holotypus: on *Salix* spec., hyperparasitic on *Phomatospora botryosphaerioides* (mixed with *Nectria guaranitica*), Brazil, Guarapí, 10-2-1883, Balansa 4102 (LPS 12478).

Hyperparasitic on *Phomatospora botryosphaerioides* (on *Salix* spec.), mycelium immersed and superficial, sometimes forming stroma-like hyphal aggregations, colonies subeffuse, whitish. Conidiophores erect, loosely to densely caespitose, about 60-80 x 5 µm, subcylindric-filiform, straight to

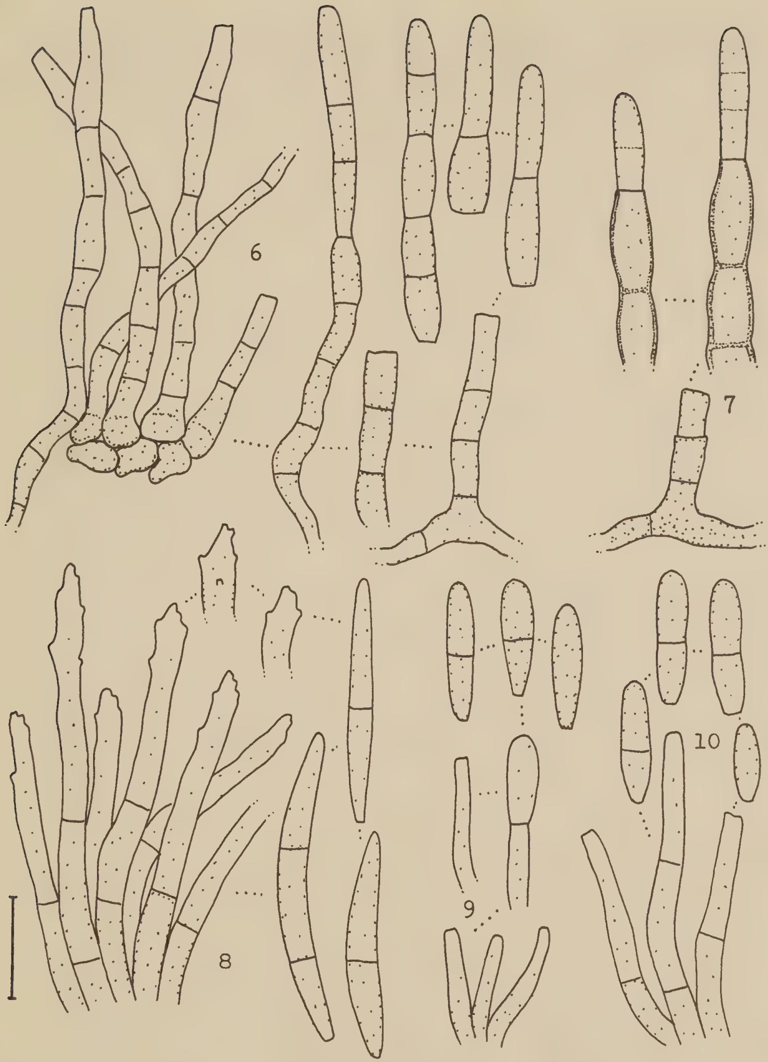

Fig. 6-10: Conidiophores, fascicles, conidia of (6) *Episporogoniella muscigena*, (7) *Sporidesmium olivascens*, (8) *Eriomycopsis guaranitica*, (9) *Monodidymaria chenopodii*, (10) *M. equiseti*. Scale 20 µm. U. Braun del.

slightly sinuous, flexuous, hyaline, septate, smooth, denticulate towards the apex, denticles minute, scattered to somewhat crowded. Conidia solitary, straight, fusiform to falcate, usually 30-60 x 4-5 µm, 0-3-septate, hyaline, smooth, apex rounded to subacute, base rounded to subtruncate.

This species is a typical *Eriomycopsis* with colourless, denticulate conidiophores.

(8) ***Monodidymaria chenopodii*** (Speg.) U. Braun **comb. nov.** - Fig. 9.

Basionym: *Ramularia chenopodii* Speg., An. Mus. nac. B. Aires 6, p. 135 (1899).

Holotypus: on *Chenopodium album* L. (Chenopodiaceae), Argentina, Córdoba, 23-12-1887, Spegazzini (LPS 12807).

The type material of this species is fairly scarce: leaf spots 1-6 mm diam., subcircular to irregular, yellowish-ochraceous to greyish - white, conidiophores filiform, ca. 20-30 x 3-4 µm, hyaline, aseptate, solitary or loosely grouped, erumpent through the cuticle, conidiogenous cells monoblastic, determinate, conidial scars inconspicuous, unthickened, neither darkened nor refractive, conidia solitary, subcylindric, ellipsoid-ovoid, 20-40 x 5-6 µm, 0-1-septate, hyaline, smooth, apex rounded, base subtruncate, unthickened.

This species matches well the concept of *Monodidymaria* U. Braun (1994). The filiform conidiophores are colourless, the conidiogenous cells are monoblastic, determinate and the conidial scars are inconspicuous, unthickened, colourless.

(9) ***Monodidymaria equiseti*** (Dobrozrakova) U. Braun **comb. nov.** - Fig. 10.

Basionym: *Cercospora equiseti* Dobrozrakova, Bol. rast. 16, p. 202 (1927).

Holotypus: on *Equisetum arvense* L. (Equisetaceae), Russia, St. Petersburg area, 23-7-1927, Dobrozrakova (LE 40397).

Syn.: *Didymaria equiseti* (Dobrozrakova) Chupp (1954, p. 205). *Ramularia dobrozrakoviana* U. Braun, Int. J. Mycol. Lichenol. 3(2-3), p. 281 (1988).

Segments or entire branchlets of the stems discoloured, pale to brown, colonies greyish, conidiophores solitary or in small fascicles, filiform, 40-120 x 3-5 µm, hyaline, continuous or septate, smooth, conidial scars inconspicuous. Conidia solitary, ellipsoid-ovoid (-subcylindrical), ca. 10-20 x 4-6 µm, 0-1-septate, hyaline, smooth, apex rounded, base rounded to truncate, hila unthickened, not darkened.

The conidiophores and conidia resemble those of *Monodidymaria* rather than *Ramularia*. Therefore, this insufficiently known species is placed in the latter genus.

(10) *Ramularia* ? *aguirrei* Speg., An. Soc. Cient. Argent. 13(1), p.27 (1882).

Typus: on *Pavonia sepium* St. Hil. (Malvaceae), Argentina, Quilares (not preserved in LPS).

According to the original description, this species is characterized as follows: leaf spots absent or epiphyllous, indefinite, diffuse, pale, colonies pulverulent, whitish to pinkish, tomentose-farinose, effuse, thin, mostly confluent, hyaline, superficial, creeping, 4-5 μm wide, interwoven; branched, erect branches (conidiophores) narrow, obtuse, conidia at the apex, catenate, cylindrical, ca. 20-40 x 5 μm, hyaline, 0-1-septate, sometimes slightly constricted.

This species possesses superficial mycelium with solitary conidiophores. It is undoubtedly a *Mycovellosiella*, close to *M. sidae, M. malvastri* and allied species which are somewhat intermediate between *Mycovellosiella* and *Ramularia*.

(11) ***Passalora oenotherae*** U. Braun **spec. nov.** - Fig. 11

Maculae amphigenae, diffusae vel irregulares, flavido-ochraceae vel brunneae, 2-8 mm diam. vel maiores. Mycelium immersum: hyphae dilute pigmentatae, septatae, ramosae. Stromata bene evoluta, substomatalia, brunnea. Caespituli amphigeni, dense aggregati, saepe confluentes, griseo-brunnei, ca. 40-150 μm diam. Conidiophora numerosa, dense fasciculata, per stomata emergentia et stomata rumpentia, recta, subcylindrica vel flexuosa, sinuosa, leniter geniculata, ca. 15-50 x 3-6 μm, laevia, flavido-viridula, olivacea vel dilute olivaceo-brunnea, continua, raro septata. Cicatrices conidiales conspicuae, leniter incrassatae, fuscae. Conidia solitaria, ovoidea, oblonga, subcylindrica, 10-30 x 3-6 μm, continua, sublaevia, subhyalina vel pallidissime flavido-viridula vel olivacea, hila leniter incrassata, fusca.

Holotypus: on *Oenothera deltoides* [Torr. & Frem.] var. *piperi* Munz. (Onagraceae), USA, Oregon, Lost River, Klamath Co., 6-7-1927, E. I. Applegate (WSP 36668).

Leaf spots amphigenous, diffuse to irregular, yellowish-ochraceous to brownish, soon greyish brown due to formation of dense caespituli, 2-8 mm diam., sometimes larger, mycelium internal, faintly pigmented, septate, branched, forming well developed stromata, substomatal, brownish. Caespituli amphigenous, dense, often confluent, greyish brown, large, 40-150 μm diam. (almost sporodochial). Conidiophores in rich, dense fascicles, arising from stromata, through the stomata, large fascicles soon widening and rupturing the stomata, conidiophores straight, subcylindric to flexuous, sinuous, slightly geniculate, ca. 15-50 x 3-6 µm, smooth, yellowish - greenish to olivaceous or yellowish brown, medium brown in mass, rarely septate, conidial scars conspicuous, slightly thickened and darkened. Conidia solitary, aseptate, ovoid, elongated, subcylindrical, 10-30 x 3-6 µm, almost smooth, subhyaline to faintly yellowish-greenish, hila slightly thickened, darkened.

The present fungus resembles *Ramularia* (*Ovularia*), but is distinguished by coloured conidiophores. It differs from "normal" *Passalora* species in constantly 1-celled conidia. *Passalora* species with 0-1-septate conidia are, however, not uncommon.

(12) ***Phaeoisariopsis hyptidis*** (Speg.) U. Braun **comb. nov.** - Fig. 12

Basionym: *Cercospora hyptidis* Speg., Boln. Acad. nac. Cienc. Córdoba 11, p. 614 (1889).

Holotypus: on *Hyptis* spec. (Lamiaceae), Brazil, Sao Paulo, Apiahy, January 1880, Puiggari 2477 (LPS 938).

Leaf spots subcircular to irregular, pale brownish to greyish white, about 3-10 mm diam., margin indefinite or somewhat darker, myelium internal. Synnemata amphigenous, mostly hypophyllous, 80-150 x 15-50 µm, individual hyphae 1-3 µm wide, septate, smooth, closely appressed, apically splaying out, conidiogenous cells terminal, pale olivaceous or brownish, straight and subcylindric to slightly geniculate-sinuous, conidial scars conspicuous, slightly thickened, darkened. Conidia solitary, obclavate (-fusiform), 30-50 x 4-5 µm, 3-4-septate, pale olivaceous, smooth, apex obtuse, base shortly obconically truncate, hila slightly thickened and darkened.

Because of the synnematous structure of the conidiomata and coloured multiseptate conidia, this species must be placed in *Phaeoisariopsis*.

(13) *Phloeosporina tubercularioides* (Speg.) U. Braun **comb. nov.** - Fig. 13.

Basionym: *Cercosporella tubercularioides* Speg., An. Mus. nac. B. Aires 20, p. 422 (1910).

Holotypus: on *Verbesina* spec. (Asteraceae), Argentina, La Plata, 20-6-1908, Spegazzini (LPS 12476).

Leaf spots pale, not very conspicuous, conidiomata hypophyllous, acervular, of subcuticular origin, ca. 50-200 µm

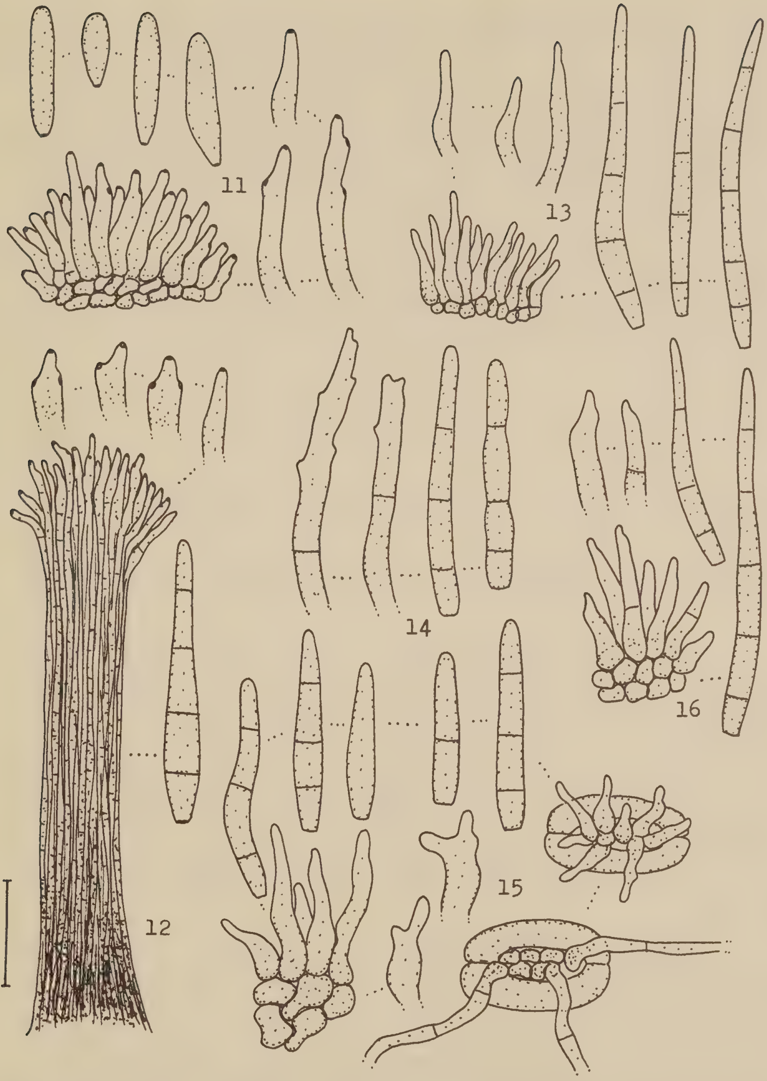

Fig. 11-16: Conidiophores, fascicles, synnema [12], conidia of (11) *Passalora oenotherae* spec. nov., (12) *Phaeoisariopsis hyptidis*, (13) *Phloeosporina tubercularioides*, (14) *Pseudocercospora mogiphanes*, (15) *P. spegazziniana*, (16) *P. unguis-cati*. Scale 20 µm. U. Braun del.

diam., sometimes larger or confluent, at first vesicular, later erumpent, flat. Conidiophores in dense, very rich layers, arising from a basal pseudoparenchymatous layer of swollen hyphae, usually 10-40 x 2-4 µm, simple, flexuous, sinuous, occasionally slightly geniculate, hyaline, continuous, smooth, conidial scars inconspicuous, unthickened, not darkened. Conidia solitary, obclavate (-subcylindrical, fusiform), 40-100 x 3-6 µm, usually 3-7-septate, hyaline, smooth, apex obtuse to subacute, base obconically truncate, unthickened.

The conidiomata of this species remind of *Phloeospora* and *Phloeosporella*, but the origin of the acervuli is undoubtedly subcuticular. The vesicular habit of young conidiomata coincides with acervuli of *Phloeosporina fraxini* (Harkn.) v. Arx.

(14) ***Pseudocercospora mogiphanes*** (Speg.) U. Braun **comb. nov.** - Fig. 14

Basionym: *Cercosporella mogiphanes* Speg., An. Mus. nac. B. Aires 20, p. 423 (1910).

Holotypus: on *Gomphrena* spec. (cf. *globosa*, Amaranthaceae), Argentina, Salta, Metán, June 1905, Spegazzini (LPS 12472).

Leaf spots subcircular, 2-8 mm diam., yellowish-ochraceous, pale brown, margin indefinite, mycelium internal, stromata substomatal, up to 45 µm diam. Caespituli amphigenous, punctiform, dark. Conidiophores fasciculate, arising from stromata, about 100-200 x 4-5 µm, straight, subcylindrical - filiform to slightly geniculate - sinuous, simple, septate, subhyaline to faintly olivaceous, smooth, subdenticulate towards the apex, conidial scars usually easily visible, often situated at the ends of short denticles, not darkened, unthickened. Conidia solitary, subcylindrical (- acicular), 20-100 x 4-7 µm, obscurely multiseptate, subhyaline, smooth, apex rounded, base subtruncate, hila unthickened, not darkened.

The conidial scars are unthickened and the conidiophores are faintly coloured. Hence, this species must be referred to *Pseudocercospora*.

(15) ***Pseudocercospora spegazziniana*** U. Braun **nom. nov.** - Fig. 15

Basionym: *Cercosporella peronosporoides* Speg., An. Soc. cient. Argent. 47, p.273 (1899), non *Pseudocercospora peronosporoidea* (Pat. & Har.) Deighton (Trans. Br. mycol. Soc. 77, p. 200, 1981) - ICBN, Article 64.3.

Holotypus: on *Manihot anisophylla* Muell. Arg. (*Jatropha anisophylla*, Euphorbiaceae), Argentina, Córdoba, April 1899, T. Stuckert 6838 (LPS 12518).

Leaf spots amphigenous, diffuse, yellowish, 1-5 mm diam., margin indefinite, primary mycelium internal, subhyaline, branched, septate, forming well developed substomatal stromata, pale olivaceous to yellowish brown, secondary hyphae superficial, arising through stomata from stromata, 1.5-4 µm wide, septate, branched, at first hyaline, later faintly coloured. Caespituli hypophyllous, pale. Conidiophores in small, loose, diffuse fascicles, arising from stromata, through stomata, rarely solitarily, from secondary hyphae, 5-20 x 2.5-6 µm, simple, flexuous, geniculate - sinuous, often irregular, continuous, rarely septate, at first hyaline, later yellowish, greenish to pale yellowish brown, conidial scars inconspicuous, unthickened. Conidia solitary, subcylindrical-obclavate, 10-60 x 3-6 (-7) µm, 0-3-septate, smooth, subhyaline, apex rounded, base rounded to truncate, unthickened.

The stromata and conidiophores are faintly coloured and the conidial scars are unthickened, not darkened. Therefore, this species is placed in *Pseudocercospora*. The epitheta "*peronosporoidea*" and "*peronosporoides*" would be so similar that they are likely to be confused (ICBN, Article 64.3.). Therefore, they are to be treated as homonyms.

(16) ***Pseudocercospora unguis-cati*** (Speg.) U. Braun comb. nov. - Fig. 16.

Basionmy: *Cercosporella unguis-cati* Speg., An. Mus. nac. B. Aires 20, p. 422-423 (1910).

Lectotypus: on *Bignonia unguis-cati* L. (Bignoniaceae), Argentina, La Plata, V. 1907, Spegazzini (LPS 33264 A).

Paralectotypus: on *B. unguis-cati*, Argentina, Buenos Aires, Santa Catalina, 29-8-1905, Spegazzini (LPS 33264 B).

Leaf spots amphigenous, subcircular, usually 3-7 mm diam., purplish brown, mycelium internal, stromata present, olivaceous. Caespituli hypophyllous, gregarious. Conidiophores fasciculate, arising from stromata, 5-50 x 3-5 µm, simple, straight and subcylindrical to geniculate - sinuous, hyaline to faintly coloured, continuous to septate, smooth, conidial scars inconspicuous, unthickened. Conidia formed singly, mostly 50-120 x 3-7 µm, 0-6-septate, acicular-obclavate, hyaline, smooth, apex subacute, base truncate, unthickened.

The type material of this species is rather scarce but, on account of the inconspicuous, unthickened conidial scars and faintly coloured stromata and conidiophores, it must be referred to *Pseudocercospora*.

(17) ***Pseudocercosporella angustana*** (Ferraris) U. Braun **comb. nov.** - Fig. 17.

Basionym: *Cercosporella angustana* Ferraris, in Ferraris & Massa, Annls. mycol. 10, p. 297 (1912).

Type: on *Taraxacum officinale* Wigg. (Asteraceae), Italy, Cogne (Vallis angustana = Val d'Aosta), Pedemont. (not seen!).

Material examined: on *Taraxacum lacerum* Greene, Canada, 1948, 1949, 1960 (DAOM 157565, 157566, 75107).

The conidiophores are solitary or in small fascicles, mostly erumpent through the cuticle, sometimes emerging through stomata. They are short, ca. 5-20 x 1.5-5 (-7) µm, hyaline, with inconspicuous, unthickened conidial scars. The conidia are formed singly, subcylindrical-acicular to narrowly obclavate, (20-) 35-75 x 2-4 µm, 0-2 (-3)-septate, hyaline.

Savile & Parmelee (1964) emphasized the probable connection between *P. angustana* and the teleomorph *Mycosphaerella taraxaci* (Karst.) Lind. Sivanesan (1984) provided a description.

(18) ***Pseudocercosporella ranunculacearum*** U. Braun **spec. nov.** - Fig. 18

Mycelium immersum: hyphae hyalinae, septatae, ramosae, 1-2 µm latae. Stroma nullum. Conidiophora solitaria vel fasciculata, exigua, per cuticulam erumpentia vel ad pseudothecia Mycosphaerellae (*M. ranunculi*), simplicia, 5-13 x 2-3 µm, subcylindrica, recta vel leniter geniculata-sinuosa, continua, laevia, hyalina. Cicatrices conidiales inconspicuae. Conidia solitaria, acicularia - filiformia, 60-130 x 1.5-3 µm, 1-4 septata, hyalina, laevia, apice subacuta, basi truncata, non incrassata.

Holotypus: on necrotic, overwintered leaves of *Ranunculus sulphureus* Soland. (Ranunculaceae), associated with pseudothecia of *Mycosphaerella ranunculi* (Karst.) Lind, Canada, Bathurst I., Franklin Distr., 25-7-1963, W. Blake 33 C (DAOM 93311).

Mycelium internal, hyaline, septate, branched, ca. 1-2 µm wide, stromata absent. Conidiophores solitary or in small fascicles, erumpent through the cuticle or associated with pseudothecia of *Mycosphaerella ranunculi*, simple, 5-13 x 2-3 µm, subcylindrical, straight to slightly geniculate - sinuous, aseptate, smooth, hyaline, conidial scars in-

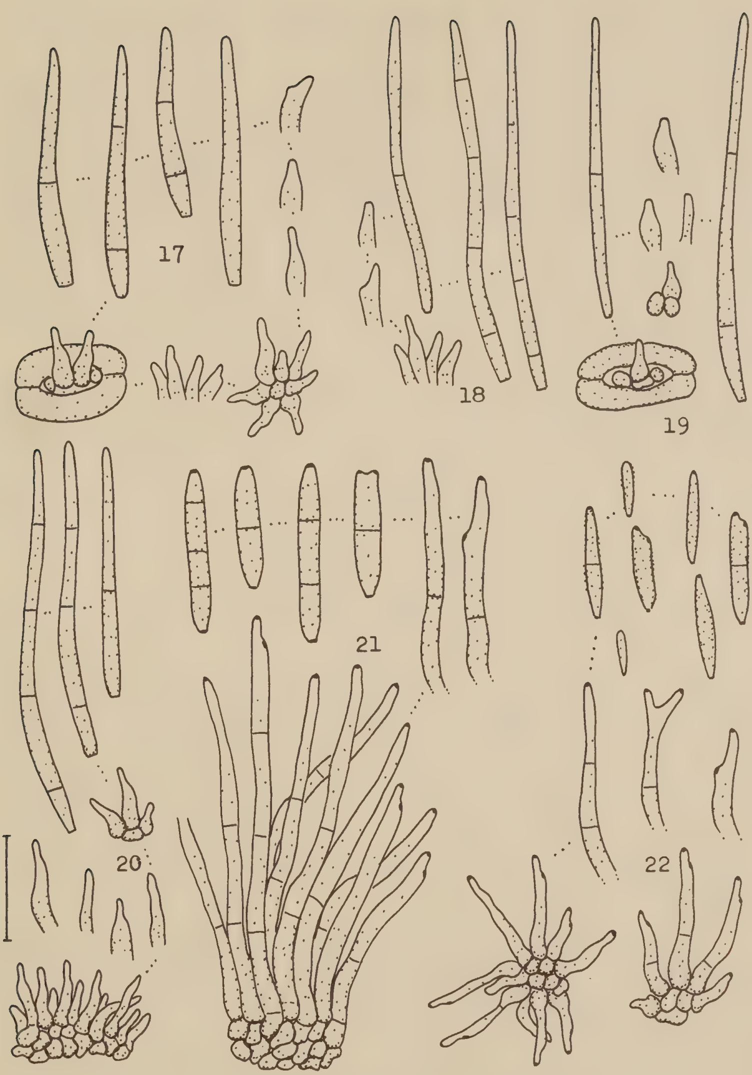

Fig. 17-22. Conidiophores, fascicles, conidia of (17) *Pseudocercosporella angustana*, (18) *P. ranunculacearum* spec. nov., (19) *P. saxifragae*, (20) *P. tonellae* spec. nov., (21) *Ramularia antennariicola* spec. nov., (22) *R. cylindroides* var. *angustispora* var. nov. Scale 20 µm. U. Braun del.

conspicuous. Conidia solitary, acicular - filiform, 60-130 x 1.5-3 µm, 1-4-septate, hyaline, smooth, apex subacute, base truncate, unthickened.

The conidial scars are unthickened, inconspicuous. Therefore, this species must be referred to *Pseudocercosporella*. It is the anamorph of *Mycosphaerella ranunculi* (Karst.) Lind (cf. Savile & Parmelee, 1964). *M. ranunculi* is known from various Ranunculaceous hosts from Europe (Norway, Finland, Switzerland, Russia), Asia (Far East of Russia), North America (Canada, USA) and Greenland (Tomilin, 1979). Barr (1972) and Sivanesan (1984) reduced *Mycosphaerella innumerella* (Karst.) Starb. to synonymy with *M. ranunculi*. According to Tomilin (l.c.), the two species are, however, morphologically distinct and *M. innumerella* is confined to Rosaceous hosts.

(19) ***Pseudocercosporella saxifragae*** (Rostrup) U. Braun **comb. nov.** - Fig. 19.

Basionym: *Cercosporella saxifragae* Rostr., Vorhandl. Krist. Vidensk. Selsk. 9, p. 13 (1891).

Type: on *Saxifraga cernua* L. (Saxifragaceae), Norway, Dorre (not seen!).

Material examined: on *Saxifraga nivalis* L., Canada, Chesterfield, 1950, Savile (DAOM 59523).

On brown, necrotic leaves, mycelium internal, hyaline, septate, branched, usually 1-2.5 µm diam., stromata absent. Conidiophores solitary or in small, loose groups, erumpent through the cuticle, emerging through stomata or associated with pseudothecia of *Mycosphaerella saxifragae* (Pass.) Lind, 4-10 x 3-5 µm, simple, subcylindrical, ampulliform, conical, continuous, hyaline, conidial scars inconspicuous. Conidia solitary, narrowly obclavate, acicular-subcylindric, 30-115 (-140) x (1-) 1.5-3.5 µm, (0-) 1-2-septate, hyaline, smooth, apex subacute, base truncate or obconically truncate, unthickened.

The type material of this species is neither preserved in C nor in some other herbaria (O, UPS). Because of the unthickened, not darkened conidial scars, this species must be placed in *Pseudocercosporella*.

(20) ***Pseudocercosporella tonellae*** U. Braun **spec. nov.** - Fig. 20.

Maculae amphigenae, irregulares, griseo-brunneae. Caespituli amphigeni, subfusco-grisei. Mycelium immersum: hyphae hyalinae, septatae, ramosae, 1-2.5 µm latae. Stromata

exigua vel bene evoluta, intraepidermalia, flavida vel pallidissime flavido-brunnea, ca. 10-40 µm diam. Conidiophora pauca vel numerosa in fasciculum laxum vel saepe densum aggregata, per cuticulam erumpentia, raro singulatim emergentia, 5-15 (-20) x (1.5-) 2-4 (-5) µm, simplicia, recta, subcylindrica vel geniculata-sinuosa, non septata, hyalina, laevia. Cicatrices conidiales inconspicuae, non incrassatae. Conidia solitaria, acicularia-obclavata, (30-) 35-80 (-90) x 1.5-3 µm, (0-) 1-4 (-5) septata, hyalina, laevia, apice subacuta, basi truncata, non incrassata.

Holotypus: on *Tonella floribunda* A. Gray (Scrophulariaceae), USA, Whitebird Summit, Idaho Co., Idaho, 20-6-1950, Jones (WSP 37966).

Leaf spots amphigenous, irregular, dull brownish, often large leaf segments or entire leaves discoloured. Caespituli amphigenous, not very conspicuous, greyish. Mycelium internal, forming small to well-developed intraepidermal stromata, yellowish to very pale yellowish brown, ca. 10-40 µm diam., occasionally almost absent. Conidiophores in small to fairly rich fascicles, loose to usually dense, arising from stromata, erumpent through the cuticle, seldom solitary. 5-15 (-20) x (1.5-) 2-4 (-5) µm, simple, straight, subcylindrical to geniculate-sinuous, continuous, hyaline, smooth, conidial scars unthickened, inconspicuous. Conidia formed singly, acicular-obclavate, (30-) 35-80 (-90) x 1.5-3 µm, (0-) 1-4 (-5)-septate, hyaline, smooth, apex subacute, base truncate, unthickened.

This species is *Cercosporella*-like, but the conidial scars are inconspicuous, unthickened. There is no comparable species on host plants of the Scrophulariaceae.

(21) ***Ramularia antennariicola*** U. Braun spec. nov. - Fig. 21.

Maculae saepe epiphyllae, brunneae, suborbiculares vel irregulares, 2-8 mm diam. Mycelium immersum: hyphae hyalinae, septatae, ramosae, 1-2.5 µm latae. Stromata bene evoluta, intraepidermalia, hyalina, -60 µm diam. Caespituli epiphylli, albidi, punctiformes, interdum aggregati. Conidiophora numerosa in fasciculis densis vel laxis aggregata, erumpentia, filiformia, saepe 20-100 x 1.5-3.5 µm, simplicia, hyalina, septata, laevia. Cicatrices conidiales conspicuae, incrassatae, fuscae. Conidia catenata, subcylindrica-fusiformia (-anguste ellipsoidea - ovoidea), ca. 15-40 x 2.5-4.5 µm, (0-) 1-2 (-3) septata, hyalina, laevia vel sublaevia, hila leniter incrassata, fusca. Fig. 21.

Holotypus: on *Antennaria anaphaloides* Rydb. (Asteraceae), USA, Middle Fork Coram, Flathead Co., 15-7-1937, E. Bachert (WSP 41580).

Leaf spots mainly epiphyllous, brown, subcircular to

irregular, 2-8 mm diam., margin indefinite, sometimes expanded. Mycelium internal, hyphae hyaline, septate, branched, 1-2.5 µm wide, stromata well developed, intraepidermal, hyaline, up to 60 µm diam. Caespituli epiphyllous, whitish, punctiform, sometimes dense. Conidiophores numerous, in rich fascicles, loose, divergent to fairly dense, erumpent through the cuticle, filiform, mostly 20-100 x 1.5-3.5 µm, simple, hyaline, septate, smooth, conidial scars thickened, darkened. Conidia in chains, subcylindrical-fusiform (- narrowly ellipsoid-ovoid), ca. 15-40 x 2.5-4.5 µm, (0-) 1-2 (-3)-septate, hyaline or subhyaline, hila slightly thickened and darkened.

This species is close to *R. anaphalidicola* U. Braun & C. T. Rogerson, but differs by narrower conidia with up to 3 septa.

(22) *Ramularia cupulariae* [Pass.] var. ***inulae-britannicae*** (Allescher) U. Braun **stat. nov.**

Basionym: *Ramularia inulae-britannicae* Allescher, in Jaap, Abh. Bot. Ver. Brandenb. 47, p. 98 (1905).

I have examined numerous specimens, including original material (e.g. Jaap, Fungi sel. exs.70; Kab. & Bub., Fungi imp. exs. 389; Krypt. exs. 2656, etc.).

Ramularia cupulariae Pass. is common and widespread on various host species of the genus *Inula* as well as *Pulicaria dysenterica* (= *Inula dysenterica*). The conidiophores are formed in small to moderately rich fascicles. They are fairly short (usually 5-25 x 2.5-5 µm). The *Ramularia* on *Inula britannica* differs by long, filiform conidiophores, up to 100 µm (10-100 x 2.5-5 µm).

(23) *Ramularia cylindroides* [Sacc.] var. ***angustispora*** U. Braun & G. Chevassut **var. nov.** - Fig. 22.

Mycelium immersum. Stromata minuta, intraepidermalia. Conidiophora pauca in fasciculis laxis aggregata, per cuticulam erumpentia, 8-45 x (1-) 1.5-3 (-4) µm, 0-2 septata, hyalina. Cicatrices conidiales conspicuae, incrassatae, fuscae. Conidia catenata, anguste ellipsoidea - ovoidea, subcylindrica-fusiformia, 4-15 (-18) x 1-3.5 µm, 0-1 septata, saepe continua, hyalina, laevia vel exigue verruculosa. Fig. 22.

Holotypus: on *Pulmonaria officinalis* L. (Boraginaceae), France, Forêt de la Jaux, 15-8-1962, Chevassut (MPU).

Mycelium internal, stromata intraepidermal, small. Conidiophores in small, loose fascicles, erumpent through the cuticle, 8-45 x (1-) 1.5-3 (-4) µm, 0-2-septate, hyaline, conidial scars thickened and darkened. Conidia in chains, narrowly ellipsoid-ovoid, subcylindrical-fusiform, 4-15 (-18) x 1-3.5 μm, 0-1-septate, mostly aseptate, hyaline, smooth vel subverruculose.

Var. *cylindroides* is characterized by conidiophores in dense, rich fascicles and larger, particularly wider conidia (8-25 x 3-6 μm). Var. *accedens* Sacc. (in Linh., Fungi hung. 296, 1883) differs by larger conidia and proliferating stromata, forming well developed secondary (superficial) hyphae.

(24) ***Ramularia eriogoni*** U. Braun spec. nov. - Fig. 23.

Maculae amphigenae, suborbiculares vel leniter irregulares, 1-15 mm diam., confluentes, rufo-brunneae, interdum zonatae, margine indistincto vel zona flavescenti lata cinctae. Mycelium immersum: hyphae hyalinae, septatae, ramosae, 1.5-4 μm latae. Stromata bene evoluta, substomatalia, hyalina vel pallide flavido-brunnea, saepe leniter erumpentia, - 50 μm diam. Caespituli amphigeni, griseo-albidi. Conidiophora saepe numerosa in fasciculis densis aggregata, 10-60 x 3-6 μm, recta, subcylindrica vel geniculata-sinuosa, hyalina, laevia, 0-1 (-2) septata. Cicatrices conidiales conspicuae, leniter incrassatae, fuscae. Conidia catenata, ellipsoidea-fusiformia, subcylindrica, 15-30 (-40) x 3-5 μm, 0-1 (-2) septata, hyalina, laevia, hila leniter incrassata, fusca.

Holotypus: on *Eriogonum elatum* Dougl. ex Benth. (Polygonaceae), USA, Ingalls Creek, Wenatchee Nat. Forest, Wash., 21-7-1955, Shaw (WSP 45934).

Leaf spots amphigenous, subcircular to somewhat irregular, 1-15 mm diam. or confluent, reddish brown, occasionally somewhat zonate, margin indefinite or with yellowish halo, mycelium internal, hyaline, septate, branched, 1.5-4 μm wide, forming well developed stromata, substomatal, up to 50 μm diam., hyaline to pale yellowish brown, often somewhat erumpent. Caespituli amphigenous, greyish white. Conidiophores fasciculate, mostly numerous, dense, 10-60 x 3-6 μm, straight, subcylindrical to geniculate - sinuous, hyaline, smooth, continuous or sparsely septate, conidial scars conspicuous, slightly thickened and darkened. Conidia catenate, ellipsoid-fusiform, subcylindrical, ca. 15-30 (-40) x 3-5 μm, 0-1 (-2)-septate, hyaline, smooth, hila slightly thickened, darkened.

This is the only *Ramularia* known on *Eriogonum*. Comparable species are unknown.

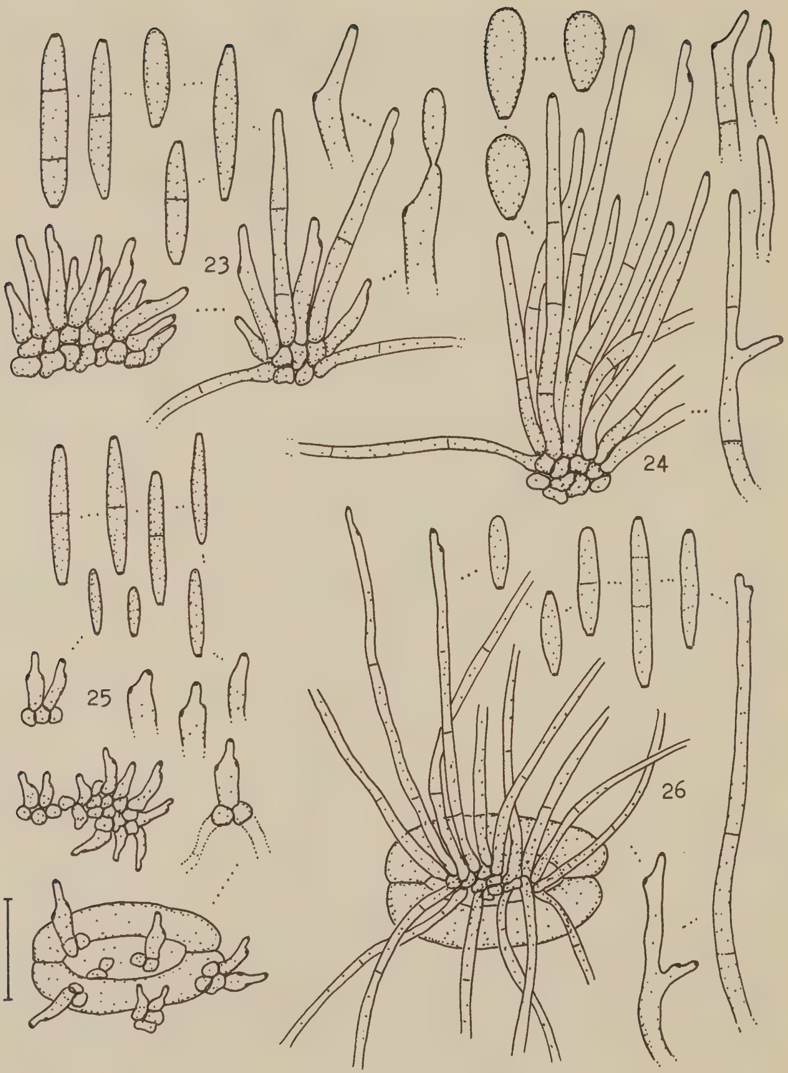

Fig. 23-26: Conidiophores, fascicles, conidia of (23) *Ramularia eriogoni* spec. nov., (24) *R. eriophylli* spec. nov., (25) *R. exigua* spec. nov., (26) *R. gunnerae*. Scale 20 µm. U. Braun del.

(25) ***Ramularia eriophylli*** U. Braun spec. nov. - Fig. 24.

Maculae amphigenae, irregulares, diffusae, flavido-brunneae. Caespituli amphigeni, griseo-albidi, punctiformes. Mycelium immersum: hyphae hyalinae, septatae, ramosae. Stromata minuta vel bene evoluta, ca. 10-60 µm diam., intraepidermalia, interdum substomatalia, saepe confluentia, subhyalina. Conidiophora pauca vel numerosa in fasciculum laxum aggregata, interdum solitaria vel caespitosa, saepe erumpentia, interdum per stomata emergentia, filiformia, 20-100 x 2-5 µm, recta vel flexuosa, simplicia, interdum ramosa, hyalina, septata, laevia, interdum leniter geniculata-sinuosa. Cicatrices conidiales conspicuae, incrassatae, fuscae. Conidia solitaria, ovoidea, subglobosa, (8-) 12-18 x 6-13 µm, non septata, hyalina, laevia vel leniter verruculosa, hila lenissime incrassata, fusca.

Holotypus: on *Eriophyllum lanatum* (Pursh) Forbes (Asteraceae), USA, Idaho, Deary, Latah Co., 11-7-1948, M. Hafercamp (WSP 43526).

Paratypi: on *E. lanatum*, USA, Montana (WSP 43586); Idaho (WSP 43578).

Leaf spots amphigenous, irregular, diffuse, yellowish brown, size variable, often large leaf segments or entire leaves discoloured. Caespituli amphigenous, greyish white, punctiform. Mycelium internal, hyphae hyaline, septate, branched, forming small to well-developed intraepidermal stromata, 10-60 µm diam., occasionally substomatal, subhyaline, often confluent. Conidiophores in small to rich fascicles, occasionally solitary, arising from inner hyphae or stromata, caespitose in severe infections, long, filiform, 20-100 x 2-5.5 µm, straight, flexuous, simple, occasionally branched, hyaline, septate, smooth, occasionally somewhat geniculate-sinuous, conidial scars conspicuous, thickened and darkened. Conidia solitary, ovoid, subglobose, (8-) 12-18 x 6-13 µm, aseptate, hyaline, smooth to faintly rough, hila slightly thickened and darkened.

This is a unique species, morphologically somewhat related to *Ramularia lupinicola* (Pollack) U. Braun.

(26) ***Ramularia exigua*** U. Braun spec. nov. - Fig. 25.

Maculae amphigenae, angulares-irregulares, 2-15 mm latae, brunneae, interdum diffusae. Caespituli hypophylli, fere inconspicui. Mycelium immersum: hyphae hyalinae, septatae, ramosae, 1-3 µm latae. Stromata nulla vel parva, intraepidermalia, interdum confluentes (- 50 µm diam.), hyalina. Conidiophora solitaria, pauca in fascicula laxa aggregata vel caespitosa, erumpentia, raro per stomata emergentia, simplicia, 5-20 (-25) x 2-4 µm, subcylindrica vel geniculata - sinuosa, continua, hyalina, laevia. Cicatrices conidiales

conspicuae, leniter incrassatae, fuscae. Conidia catenata, subcylindrica - fusiformia, anguste ellipsoidea - ovoidea, (5-) 8-25 (-32) x 1.5-3 µm, 0-1 septata, hyalina, sublaevia vel verruculosa, hila leniter incrassata, fusca. Fig. 25.

Holotypus: on *Ranunculus uncinatus* G. Don ex D. Don (Ranunculaceae), USA, Canyon Creek, Crant Co., Oregon, 27-5-1950, M. E. Peck (WSP 36203).

Paratypus: on *Ranunculus cymballaria* Pursh, USA, Idaho (WSP 36082).

Leaf spots amphigenous, angular - irregular, brown, sometimes diffuse, margin indefinite, 2-15 mm diam., sometimes large leaf segments or entire leaves necrotic, brown. Caespituli hypophyllous, fairly inconspicuous. Mycelium internal, hyphae septate, branched, 1-3 µm wide, stromata absent, occasionally small aggregations of a few swollen hyphae below the leaf surface, colourless. Conidiophores solitary or in small groups, loose, erumpent through the cuticle, simple, 5-20 (-25) x 2-4 µm, subcylindrical to geniculate-sinuous, continuous, hyaline, smooth, conidial scars conspicuous, slightly thickened and darkened. Conidia catenata, subcylindrical - fusiform, very narrowly ellipsoid - ovoid, (5-) 8-25 (-32) x 1.5-4 µm, 0-1-septate, hyaline, verruculose, hila slightly thickened, darkened.

I have examined nine additional specimens on *Ranunculus uncinatus* from Idaho, Montana, Oregon, Washington and Wyoming (WSP 36029, 36052, 36090, 36091, 36095, etc.). *R. exigua* is allied to *R. didyma* Ung. (= *aequivoca*), but differs in conidiophores erumpent through the cuticle and narrower conidia.

(27) ***Ramularia gunnerae*** (Speg.) U. Braun **comb. nov.** - Fig. 26.

Basionym: *Ovularia gunnerae* Speg., Revta. Fac. Agron. Vet. La Plata, ep. 2, 6, p. 180 (1910).

Holotypus: on *Gunnera chilensis* Lam. (Haloragaceae), Chile, Valdivia, 1909, Spegazzini (LPS 13252).

This species is a true *Ramularia*. The conidiophores are formed in loose, divergent fascicles, emerging through stomata. They are filiform, simple, 10-100 x 2-4 µm, hyaline, septate. The conidial scars are thickened and darkened and the conidia are catenate, narrowly ellipsoid - ovoid, fusiform, cylindrical, 6-35 x 2-3, 0-1 (-2)-septate, verruculose.

(28) ***Ramularia ligusticicola*** U. Braun **spec. nov.** - Fig. 27.

Maculae amphigenae, brunneae, angulares - irregulares, minutae, 0.5-3 mm diam., interdum venis limitatae, margine indistincto vel zona flavescente lata cinctae. Caespituli amphigeni, punctiformes, griseo-albidi. Mycelium immersum: hyphae hyalinae, septatae, ramosae, 1.5-3 µm latae. Stromata nulla vel parva, intraepidermalia, hyalina, interdum proliferentia. Conidiophora solitaria vel laxe fasciculata, per cuticulam erumpentia, raro per stomata emergentia, erecta vel horizontalia, ca. 10-100 x 2-4 µm, recta, subcylindrica, filiformia vel flexuosa, leniter geniculata - sinuosa, simplicia, interdum ramosa, hyalina, laevia, continua vel septata. Cicatrices conidiales conspicuae, incrassatae, fuscae. Conidia catenata, ellipsoidea - fusiformia, subcylindrica, 10-28 x 1.5-3 (-4.5) µm, 0-1 septata, hyalina, laevia, hila leniter incrassata, fusca.

Holotypus: on *Ligusticum grayi* J. M. Coulter & J. Rose (Apiaceae), USA, Wash., Mt. Rainier, Aug. 1895, Piper (WSP 35230).

Leaf spots amphigenous, brown, angular-irregular, small, 0.5-3 mm diam., margin indefinite, sometimes vein-limited, occasionally with yellowish halo. Caespituli amphigenous, punctiform, greyish white. Mycelium internal, hyphae hyaline, septate, branched, 1.5-3 µm wide, stromata absent or small, intraepidermal, hyaline, sometimes proliferating, forming long, creeping hyphae. Conidiophores solitary or in small, loose fascicles, erumpent through the cuticle, from inner hyphae or stromata, rarely through stomata, erect to horizontally spread, 10-100 x 2-4 µm, straight, subcylindrical, filiform, flexuous, slightly geniculate - sinuous, simple, occasionally branched, hyaline, smooth, septate, conidial scars conspicuous, thickened, darkened. Conidia in chains, ellipsoid-fusiform, subcylindrical, 10-28 x 1.5-3 (-4.5) µm, 0-1-septate, hyaline, smooth, hila slightly thickened and darkened.

This species is closely allied to the European *Ramularia peucedani* Hollós. The stromata in the latter species are, however, substomatal.

(29) ***Ramularia phlogis*** U. Braun **spec. nov.** - Fig. 28.

Maculae amphigenae, suborbiculares, irregulares, diffusae, 1-6 mm diam., dilute brunneae, griseo-brunneae, interdum zona flavescente lata cinctae. Caespituli amphigeni, punctiformes, griseo-albidi. Mycelium immersum: hyphae hyalinae, septatae, ramosae, 1-2.5 µm latae. Stromata bene evoluta, substomatalia, 10-40 µm diam., hyalina vel subhyalina. Conidiophora numerosa in fasciculum laxum aggregata, divergentia, filiformia, flexuosa, 10-100 x 1.5-3.5 µm, simplicia, interdum ramosa, hyalina, laevia, saepe septata,

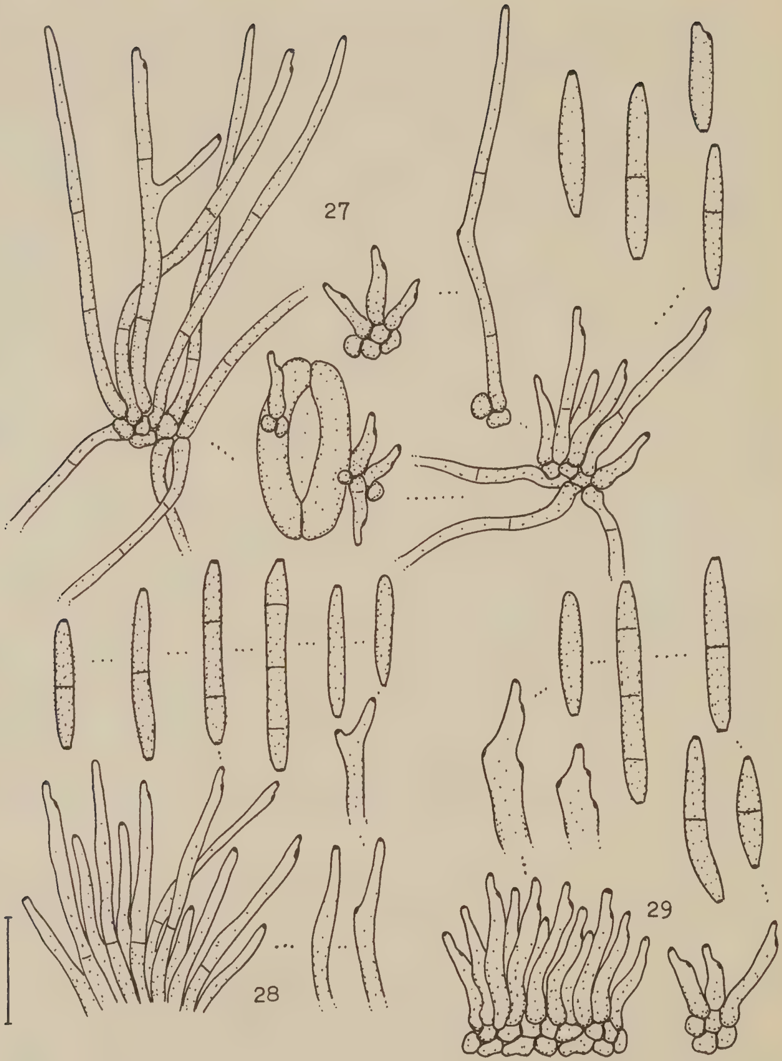

Fig. 27-29: Conidiophores, fascicles, conidia of (27) *Ramularia ligusticicola* spec. nov., (28) *R. phlogis* spec. nov., (29) *R. sanguisorbicola* spec. nov. Scale 20 µm. U. Braun del.

interdum apice leniter geniculata. Cicatrices conidiales leniter incrassatae, fuscae. Conidia solitaria vel catenata, subcylindrica (- anguste ellipsoidea), (10-) 15-40 (-45) x 1.5-3.5 µm, 0-3 septata, hyalina, laevia vel verruculosa, hila leniter incrassata, fusca. Fig. 28.

Holotypus: on *Phlox kelseyi* Britt. (Polemoniaceae), USA, Montana, McDonald Lake, Mission Range, Lake Co., 12-7-1948, Hitchcock (WSP 36122).

Paratypus: on *Phlox speciosa* [Pursh] ssp. *lanceolata* (E. Nels.) Wherry, USA, Sanpoil R., ca. 60 km N. of Wilbor, Ferry Co., Wash., 21-6-1948, Hitchcock (WSP 36225).

Leaf spots amphigenous, subcircular to irregular, diffuse, pale brown to greyish brown, 1-6 mm diam., sometimes with a yellowish halo. Caespituli amphigenous, punctiform, greyish white. Mycelium internal, hyphae hyaline, septate, branched, 1-2.5 µm diam., forming well developed substomatal stromata, 10-40 µm wide, hyaline or subhyaline. Conidiophores in small to fairly rich fascicles, arising from stromata, through stomata, loose, divergent to moderately dense, filiform, flexuous, 10-100 x 1.5-3.5 µm, simple, occasionally branched, hyaline, smooth, septate, sometimes slightly geniculate - sinuous towards the apex, conidial scars thickened and darkened. Conidia solitary or catenate, subcylindrical (-narrowly ellipsoid), (10-) 15-40 (-45) x 1.5-3.5 µm, 0-3-septate, hyaline, smooth to verruculose, hila slightly thickened, darkened.

This species is close to *Ramularia giliae* Sprague, but well distinguished by narrower conidia and more slender conidiophores in loose, divergent fascicles.

(30) ***Ramularia sanguisorbicola*** U. Braun spec. nov. - Fig. 29.

Maculae necroticae, magnae, siccae, brunneae, interdum purpurascentes. Caespituli amphigeni, punctiformes vel subeffusi, griseo-albidi. Mycelium immersum: hyphae hyalinae, septatae, ramosae, 1-3 µm latae. Stromata parva vel bene evoluta, intraepidermalia, raro substomatalia, interdum confluentes, hyalina, ex hyphis inflatis, 2.5-6 µm latis, composita. Conidiophora pauca vel modice numerosa in fascicula laxa vel densa aggregata, per cuticulam erumpentia, raro per stomata emergentia, simplicia, ca. 6-30 x 2-5 µm, recta, subcylindrica vel geniculata - sinuosa, 0-1 septata, hyalina, laevia. Cicatrices conidiales conspicuae, incrassatae, fuscae. Conidia catenata, subcylindrica (- ellipsoidea-ovoidea, fusiformia), (8-) 15-30 (-35) x 2-3.5 (-4) µm, 0-3 septata, hyalina, laevia vel lenissime verruculosa, hila leniter incrassata, fusca.

Holotypus: on *Sanguisorba annua* (Nutt. ex Hook.) Nutt. ex

Torr. & A. Gray (Rosaceae), USA, Idaho, foot of Moscow Mts., Latah Co., 4-5-1948, Shaw (WSP 31949).

Paratypus: on *S. annua*, USA, Idaho, Latah Co., 14-7-1951, Gaines & Clark (WSP 38848).

Leaf spots large, necrotic, dry, brown, occasionally purplish. Caespituli amphigenous, punctiform or subeffuse, greyish white. Mycelium internal, hyphae hyaline, septate, branched, 1-3 µm wide, forming small to well-developed intraepidermal stromata, rarely substomatal, hyaline, composed of swollen hyphae, ca. 2.5-6 µm wide. Conidiophores in small to moderately rich fascicles, loose to fairly dense, erumpent through the cuticle, rarely through stomata, simple, ca. 6-30 x 2-5 µm, straight, subcylindrical to geniculate - sinuous, 0-1-septate, hyaline, smooth, conidial scars slightly thickened and darkened. Conidia catenate, cylindrical (- fusiform), (8-) 15-30 (-35) x 2-3.5 (-4) µm, 0-3-septate, hyaline, smooth to faintly rough, hila slightly thickened, darkened.

Ramularia arvensis Sacc. is related to this species, but differs by forming distinct leaf spots and conidiophores arising through stomata.

(31) ***Ramularia tecta*** U. Braun, G. Chevassut & P. Pellicier spec. nov. - Fig. 30.

Maculae amphigenae, suborbiculares, irregulares, griseoviridulae, griseo-brunneae, 1-10 mm diam. Caespituli amphigeni, saepe hypophylli, inconspicui. Mycelium primarium immersum: hyphae hyalinae, septatae, ramosae, 0.5-1.5 µm latae. Mycelium secundarium superficiale: hyphae e stomatibus emergentes, repentes, hyalinae, septatae, ramosae, 0.5-2 µm latae. Stroma nullum. Conidiophora solitaria, e mycelio secundario oriunda, 5-20 x 1.5-4 µm, simplicia, subcylindrica, recta vel geniculata - sinuosa, 0-1 septata, hyalina, laevia. Cicatrices conidiales conspicuae, lenissime incrassatae, fuscae. Conidia catenata, ellipsoidea-ovoidea, subcylindrica-fusiformia, 4-15 x 1.5-3 µm, 0-1 septata, hyalina, sublaevia vel verruculosa, hila lenissime incrassata, fusca.

Holotypus: on *Symphytum officinale* L. (Boraginaceae), France, Département de l'Ain, Balan, Camp de la Valbonne, env. 30 km de Lyon, 4-6-1990, P. Pellicier (HAL).

Leaf spots amphigenous, subcircular, irregular, greyish green, greyish brown, 1-10 mm diam. Caespituli amphigenous mainly hypophyllous, inconspicuous. Primary mycelium internal, hyphae hyaline, septate, branched, 0.5-1.5 µm diam., secondary mycelium external, superficial, hyphae emerging through stomata, hyaline, septate, branched, 0.5-2 µm diam., stromata absent. Conidiophores solitary, arising from secondary hyphae, 5-20 x 1.5-4 µm, simple, subcylindric, straight to geniculate - sinuous, 0-1-septate, hyaline, smooth, conidial scars slightly thickened and darkened. Conidia catenate, ellipsoid-ovoid, subcylindrical - fusiform, 4-15 x 1.5-3 µm, 0-1-septate, hyaline, almost smooth to verruculose, hila slightly thickened and darkened.

The present species is closely allied to the North American *Ramularia maculicola* U. Braun & C. T. Rogerson (1992), but differs in having wide, verruculose conidia. *Ramularia calcea* Ces. (= *R. farinosa* (Bon.) Sacc., *R. asperifolii* Sacc.), the common *Ramularia* species on *Symphytum* is characterized by fasciculate conidiophores and larger conidia. Superficial mycelium is absent.

(32) ***Rhexocercosporidium*** **U. Braun gen. nov.**

Deuteromycotina, Hyphomycetes. In radicibus, petiolis et foliis parasiticum. Mycelium immersum et/vel superficiale: hyphae septatae, ramosae, subhyalinae, olivaceae vel brunneae, laeves. Maculae fusco-atratae. Conidiophora sparsa, solitaria, ex hyphis immersis vel repentibus lateralia vel terminalia oriunda, semi-macronematosa, subhyalina, continua vel septata, laeves. Cellulae conidiogenae integratae, terminales, raro intercalares, subcylindricae, doliiformes, monoblasticae vel polyblasticae, sympodiales, subhyalinae, laeviae. Cicatrices conidiales subtruncatae, incolores, non incrassatae, fere inconspicuae. Conidia solitaria, rhexolytice secedentia, subcylindrica (-ellipsoidea, ovoidea), (0-) 1-8, saepe 3 septata, subhyalina, laevia, ad apicem rotundata, basi subtruncata, incolores, non incrassata.

Type species: *Acrothecium carotae* Årsvoll (= *Rhexocercosporidium carotae* (Årsvoll) U. Braun)

Deuteromycotina, Hyphomycetes. Biotrophic plant parasites, at roots, petioles and leaves. Mycelium immersed and/or superficial, hyphae septate, branched, subhyaline, olivaceous to brown, smooth, forming dark brown to almost black spots. Conidiophores scattered, solitary, arising from internal hyphae, erumpent, or as lateral branches from superficial, creeping hyphae, occasionally terminal, little differentiated (semi-macronematous), subhyaline, continuous or septate, smooth. Conidiogenous cells integrated, terminal, rarely intercalary, subcylindrical, doliiform, monoblastic or polyblastic, sympodial, subhyaline, smooth. Conidial scars subtruncate, colourless, unthickened, fairly inconspicuous, with minute frill. Conidia solitary, secession rhexolytic, subcylindrical (- ellipsoid, ovoid), (0-) 1-8-, mostly 3-septate. subhyaline, smooth, apex rounded, base subtruncate, colourless, not thickened, with minute frill.

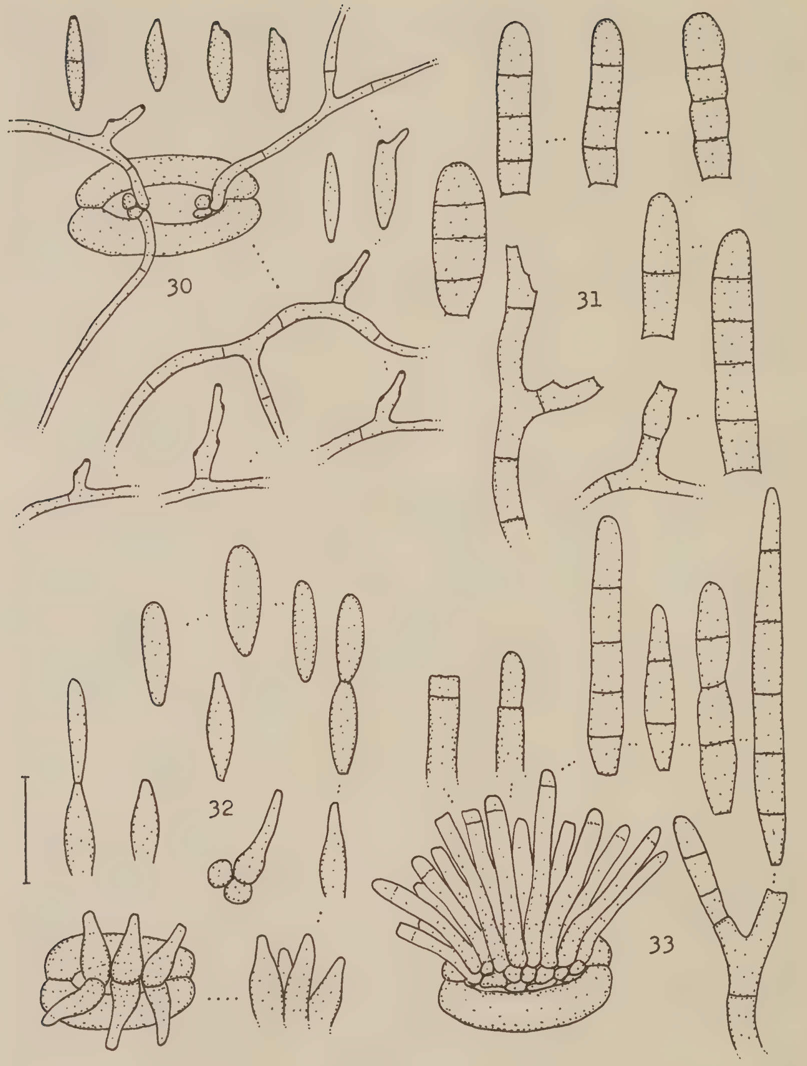

Fig. 30-33: Conidiophores, fascicles, conidia, superficial mycelium [30, 31] of (30) *Ramularia tecta* spec. nov., (31) *Rhexocercosporidium carotae*, (32) *Spermosporina phyllactidis*, (33) *Stigmina dispori* spec. nov. Scale 20 µm. U. Braun del.

Rhexocercosporidium carotae (Årsvoll) U. Braun **comb. nov.** - Fig. 31.

Basionym: *Acrothecium carotae* Årsvoll, Acta Agr. Scand. 15, p. 112 (1965).

Syn.: *Pseudocercosporidium carotae* (Årsvoll) de Hoog & van Oorschot, Stud. in Mycol. 26, p. 103 (1985).

Examined material: CBS 418.65 (subcultures of the type isolate).

This is a soil-borne pathogen, causing blackish spots on stored carrots (on roots and foliage) and damping-off of young seedlings. Growing plants are rarely infected, but injured roots may occasionally be attacked. It seems to be confined to carrots (cf. Årsvoll, l.c.). On leaves and petioles, the coloured mycelium is immersed, on roots it grows superficially (hyphae ca. 1-5 µm wide, septate, branched, smooth, subhyaline, olivaceous to brown). The conidiophores break through the epidermal cells (on foliage), arising from internal hyphae, or they emerge from superficial hyphae (on roots). They are about 5-80 x 3-8 µm, mostly short, erect, 0-3-septate, subhyaline, subcylindrical, often somewhat swollen, especially at the base, occasionally at the apex. The conidia are subcylindrical (-ellipsoid, ovoid), 10-65 x 4-8 µm, mostly 15-35 µm long, thin-walled, (0-) 1-8-, mostly 2-5-septate, old conidia sometimes constricted at the septa and faintly coloured, germ tubes simple, rarely branched, arising from any point of the conidial surface.

Årsvoll (1965) described this species from Norway, discussed all aspects of its pathogenicity and provided illustrations. He referred it to *Acrothecium* (= nom. dub., cf. Hughes, 1958). De Hoog & van Oorschot (1985) pointed out the rhexolytic secession of the conidia in *A. carotae* and transferred this species to *Pseudocercosporidium* Deighton (1973). But the latter genus is not appropriate for *A. carotae*. *P. venezuelanum* (H. Syd.) Deighton, the type species of *Pseudocercosporidium*, is well charcterized by very long, branched, coloured conidiophores and conidiogenous cells with quite distinct conidial scars (old scars conspicuous, highly refractive thickened convex caps). Very minute frills are present, but the conidial secession is undoubtedly schizolytic (very minute "frills" are not uncommon in various genera of the *Cercospora* complex, e.g. in *Pseudocercospora, Cercostigmina, Stigmina*).

(33) **Spermosporina phyllactidis** (Speg.) U. Braun **comb. nov.** - Fig. 32.

Basionym: *Ovularia phyllactidis* Speg., An. Mus. nac. B. Aires 20, p. 418 (1910).

Holotypus: on *Phyllactis* spec. ["*salicariifolia*"] (Valerianaceae), Argentina, La Plata, 29-8-1904, Spegazzini (LPS 13256).

Leaf spots amphigenous, subcircular, 8-13 mm diam., subzonate, brown, greyish brown, margin indefinite or dark, dull violet to almost black. Caespituli hypophyllous, not very conspicuous. Mycelium internal, hyaline. Conidiophores (conidiogenous cells) solitary or in small fascicles, emerging through stomata or erumpent throug the cuticle, subcylindrical, conical, ampulliform, simple, ca. 10-25 x 4-5 µm, hyaline, monoblastic (or ? monophialidic), conspicuous conidial scars lacking. Conidia solitary or in short chains, ellipsoid - ovoid (- subcylindrical, lemon-shaped), 10-12 x 2.5-4 µm, aseptate, hyaline, smooth, ends rounded to truncate, hila unthickened, not darkened. Fig. 32.

This species is tentatively placed in *Spermosporina* Braun (1993c). It is very close to the latter genus, but the conidia are aseptate and partly catenate. Some conidiogenous cells looked rather like small phialides. The type material is, however, too scarce to allow additional, comprehensive investigations.

(34) ***Stigmina dispori*** U. Braun **spec. nov.** - Fig. 33.

Maculae amphigenae, angulares-irregulares, ca. 1-5 mm diam., vel confluentes, et maiores, flavido-ochraceae, brunneae, margine indistincto. Conidiomata (sporodochia) amphigena, saepe hypophylla, punctiformia, flavida, brunnea, atrata. Mycelium immersum: hyphae coloratae. Stromata bene evoluta, substomatalia. Conidiophora numerosa, dense fasciculata, per stomata emergentia, subcylindrica, subclavata, recta vel leniter flexuosa, 10-40 x 2-6 µm, simplicia, interdum ramosa, continua vel septata, subhyalina, flavida vel brunnea, laevia. Cellulae conidiogenae monoblasticae, determinatae vel percurrentes. Cicatrices conidiales non incrassatae, non coloratae. Conidia solitaria, subcylindrica, subclavata, obclavata, 25-60 x 4-9 µm, (0-) 2-5 septata, interdum constricta, laevia, subhyalina vel lenissime flavido-viridula, olivacea, apice obtusa, basi truncata, non incrassata.

Holotypus: on *Disporum hookeri* (Torr.) Nichols. (Liliaceae), USA, Wash., Lilliwaup, Mason Co., 27-7-1937, L. K. Jones (WSP 35442).

Leaf spots amphigenous, angular - irregular, ca. 1-15 mm diam., or confluent and larger, often large leaf segments or entire leaves discoloured, yellowish ochraceous, later brownish, margin indefinite. Caespituli amphigenous, mostly hypophyllous, punctiform, yellowish, brownish, finally almost black. Mycelium internal, coloured, forming well-developed substomatal stromata. Conidiophores fasciculate, sporodochial, arising from stromata, through stomata, fascicles rich and dense, conidiophores subcylindrical, subclavate, straight to somewhat flexuous, 10-40 x 2-6 µm, simple, occasionally branched near the apex, continuous or septate, at first subhyaline, later yellowish to brown, smooth, conidiogenous cells monoblastic, determinate or percurrent, conidial scars unthickened, not darkened. Conidia solitary, subcylindrical, subclavate, obclavate, 25-60 x 4-9 µm, (0-) 2-5-septate, occasionally constricted at the septa, smooth, subhyaline to faintly yellowish green, olivaceous, apex obtuse, base truncate, unthickened.

This is the only *Stigmina* known on *Disporum*. Comparable species on other Liliaceous host plants are unknown.

Acknowledgements

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A NEW FOLIICOLOUS SPECIES OF MICROTHELIOPSIS (LICHENS, MICROTHELIOPSIDACEAE) FROM COSTA RICA

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Summary

Microtheliopsis winklerii sp.n., characterized by setose thallus, submuriform spores, and epiphyllous growth habit, is described and illustrated. Its relationship to *M. uleana*, the up to now only species of the genus, and the remarkable formation of sporangia by the symbiotic alga in both species, are discussed.

Introduction

Microtheliopsis was introduced by Müller Arg. (1890) to accomodate a single, peculiar foliicolous lichen, *M. uleana* Müll.Arg., characterized by perithecioid ascomata, bitunicate asci, lack of paraphyses, 3-septate, brownish spores with cylindrical cell lumina, and *Phycopeltis* as symbiotic alga (Santesson 1952, Eriksson 1981). Due to the combination of characters and the very much reduced morphology of thallus and ascomata, the systematic position of *Microtheliopsis*, up to now a monotypic genus, has remained obscure for most of the time. According to Santesson (1952), *M. uleana*, and the later described

Micropyrenula olivacea Vain. (Vainio 1921), a synonym of *Microtheliopsis uleana*, were referred to no less than five different families by previous authors, viz. Strigulaceae (Zahlbruckner 1926), Arthopyreniaceae (Watson 1929), Pyrenulaceae (Watson 1929, Räsänen 1943), Gloeophragmiaceae (Räsänen 1943) and Microtheliopsidaceae (Mattick 1951), the latter not validly published. Santesson (1952) adopted the position in Pyrenulaceae, which he regarded as provisional, although pointing out that it may be a much reduced member of that family.

Eriksson (1981) discussed the systematic relationships of *Microtheliopsis* and thought it to be related to the non-lichenized Herpotrichiellaceae Munk. He therefore validly established the family Microtheliopsidaceae, which later was placed in Dothideales (Eriksson & Hawksworth 1987). In several respects *Microtheliopsis* agrees also with Verrucariaceae, which is reflected by results of a cladistic analysis of tropical pyrenocarpous lichens performed by Aptroot (1991).

In the following a new species of *Microtheliopsis* is described, found on leaves at two localities in Costa Rica, Central America.

Microtheliopsis winkleri R. Lücking sp.n.

Thallus epiphyllus, crustosus, tenuissimus, dispersus vel parte centrali continuus; maculae thallines 2-5 mm diam., singulae vel confluentes, pallide flavescenter-fuscae vel flavescenter virides, leviter nitidae, laevigatae vel sporangiis algarum granulosae, setis nigro-fuscis, c. 0,1 mm longis 4-5 µm crassisque instructae. - Perithecia lenticulata vel conica, basi rotundata vel leviter ellipsoidea, 0,2-0,3 mm diam., fusco-nigra. - Paries bipartitus; paries externus nigro-fuscus, strato algarum hyphis fuscis instructo formatus; paries internus nigro-fuscus, hyphis fuscis. - Paraphyses nullae. - Asci obclavati vel pyriformes, fissitunicati, 45-55 x 15-20 µm. - Sporae 8-nae, late fusiformes vel ellipsoideae, submuriformes, maturitate pallide cinereo-fuscis, 12-15 x 5-6 µm. - Alga ad *Phycopeltem* pertinens, saepe centro macularum thallinium sporangia formans.

Holotype: Costa Rica, San José province, San Cristobal, c. 20 km SSE of San José, 11 km NNW of Cartago at Interamerican highway (San Cristobal-turnoff, km 40,5); 83°59'W / 9°47'N; c. 1900m; tropical upper montane rain forest zone; small gallery forest along river near road, on leaves of Ericaceae. - Leg. R. Lücking VII. 1991, n. 91-3561 (M). - Isotypes: herb. R. Lücking; LICHENES FOLIICOLI EXSICCATI).

Thallus epiphyllous, crustose, dispersed or in central part continuous, thallus patches 2-5 mm in diam., single or confluent, c. 10 µm thick, dominated by the single algal layer, pale yellowish brown to yellowish green, slightly nitidous, smooth or granulose by formation of algal sporangia, provided with numerous blackish brown, c. 0,1 mm long and 4-5 µm broad fungal hairs.

Perithecia lens-shaped to conical, rounded or sometimes slightly elongate in outline, 0,2-0,3 mm in diam. and c. 0,1 mm high, brownish black; outer perithecial wall blackish brown, formed by dark brown fungal hyphae surrounding the conically raised algal layer; inner wall of same colour as outer wall, composed of dark brown hyphae and forming an applanate chamber, 0,15-0,2 mm in diam., 50-70 µm high, containing asci and spores. Perithecial contents I+ yellowish red, KOH/I+ blue. Paraphyses absent. Asci obclavate to pear-shaped, distinctly fissitunicate, 45-55 x 15-20 µm. Spores 8 per ascus, broadly fusiform to ellipsoid, submuriform, with 3(-5) transverse septa and one or both of the median cells usually with a longitudinal septum, rarely with secondary transverse septa, pale greyish brown when mature, 12-15 x 5-6 µm.

Symbiotic alga a species of *Phycopeltis*, often producing sporangia in centre of thallus patches, cells rectangular, 12-17 x 6-10 µm, forming regularly radiate plates.

Ill.: Fig. 1 (a-d) spores, (e) mature ascus, (f) section through ascocarp, (g) setae of thallus, (h) symbiotic alga.

Additional specimens examined: Costa Rica, type locality; on leaves of dicotyledon, n. 91-3619, and leaves of fern, n. 91-3631 (both herb. R. Lücking). - Tapanti national wildlife refuge, Cartago province, c. 35 km ESE of San José, 15 km SE of Cartago, atlantic slope of Cordillera de Talamanca; 83°47'W / 9°46'N; 1800m; tropical montane to upper montane rain forest zone; secondary vegetation at "Mirador", 4,5 km after park entrance, on leaves of Ericaceae, n. 91-3906 (herb. R. Lücking).

Microtheliopsis winkleri is dedicated to my initial supervisor Prof. Dr. S. Winkler, who stimulated me in studying foliicolous lichens, and who suddenly and for everyone unexpectedly died in April 1992.

The new species is closely related and externally similar to *M. uleana*, a species common in Costa Rica (Lücking 1992), but differs in certain respects, i.e. the setose thallus and the larger, submuriform spores. Spores of *M. uleana* are constantly 3-septate (very rarely 4-septate) and distinctly smaller (9-13 x 2,5-4 µm, fig. 1 i-l). Further, thallus patches of *M. uleana* are larger on an average (3-8 mm), often polycarpous, and with smaller (0,1-0,25 mm diam.), radially elongated and concentrically arranged perithecia. As far as the material allows to state, *M. winkleri* has smaller, mono- to oligocarpous thallus patches, and larger, mostly rounded and irregularly distributed perithecia.

A peculiarity found in both species is the regular formation of sporangia by the symbiotic alga. This might indicate a primitive or reduced type of lichenisation, as discussed by Santesson (1952) and Eriksson (1981). However, in material of *M. uleana* from Costa Rica formation of algal sporangia was repeatedly observed to be more frequent on fertile thalli of that species than on young thalli or free living *Phycopeltis* colonies, indicating that the fungus may have a kind of stimulating effect on the symbiotic alga to reproduce itself by means of sporangia, at the same time when ascospores get mature. This is not unlikely as it increases the possibility of the released ascospores to get contact to free algal cells when a new lichen thallus is to be established.

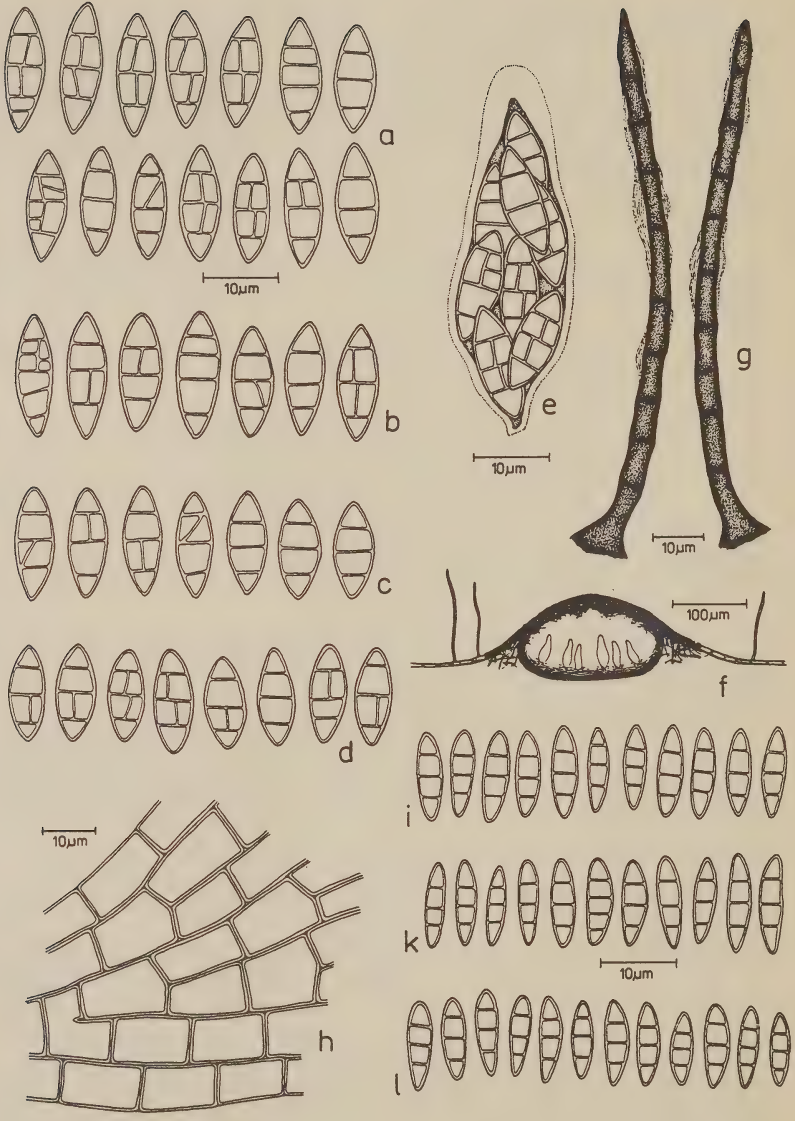
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Fig. 1. (a-h) *Microtheliopsis winkleri* sp.n., (i-l) *M. uleana*. (a-d, i-l) ascospores, (e) mature ascus, (f) section through thallus with setae and ascocarp, (g) setae, (h) cells of symbiotic alga. (a, e-h) holotype (M), (b) n. 91-3619, (c) n. 91-3631, (d) n. 91-3906, (i) n. 91-5521, (k) n. 87-335, (l) n. 92-1851 (all herb. R. Lücking)

Acknowledgements

I am grateful to the German Academic Exchange Service (DAAD) for the financial support of an 17-month research stay in Costa Rica, during which the new species was collected. The Wildlife Service (Vida Silvestre) of Costa Rica kindly gave the permission for gathering at the respective localities. I am further indepted to Prof. Dr. O. Eriksson for critical remarks on the manuscript. For valuable help with the layout I wish to thank G. Hinze and H. Grambihler.

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STUDIES ON KERATINOPHILIC FUNGI. III.
CHRYSOSPORIUM SIGLERAE SP. NOV.

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ABSTRACT

Chrysosporium siglerae *sp. nov.* described and illustrated from two strains isolated from Spanish soils, is characterized by its slow colony growth rate and by the brownish conidia in mass which are frequently bicellular.

RESUMEN

Se describe e ilustra a partir de dos cepas, un nuevo hongo queratinofílico, ***Chrysosporium siglerae*** *sp.nov.*, aislado de muestras del suelo de nuestro país. Las características más representativas del mismo son el lento crecimiento de la colonia y la presencia de conidios parduzcos en masa y frecuentemente bicelulares.

In our studies on keratinophilic fungi from Spanish soils, we have isolated many species of taxonomic interest using the hair baiting method (Vanbreuseghem, 1952). One of them, ***Chrysosporium siglerae*** *sp. nov.*, is described and illustrated below.

Chrysosporium siglerae Cano et Guarro *sp. nov.*
Etymology: honouring Dr. Lynne Sigler, an eminent Canadian mycologist.

Coloniae in agaro phytone extracto levedinis ad 28°C, densae, tardissime crescentes, fulvae gilvae vel leviter alutaceae (luteo-fuscae), luteae ad margem. Hyphae hyalinae, septatae, 2 - 2.5 µm latae. Hyphae fertiles ramosae. ***Conidia***

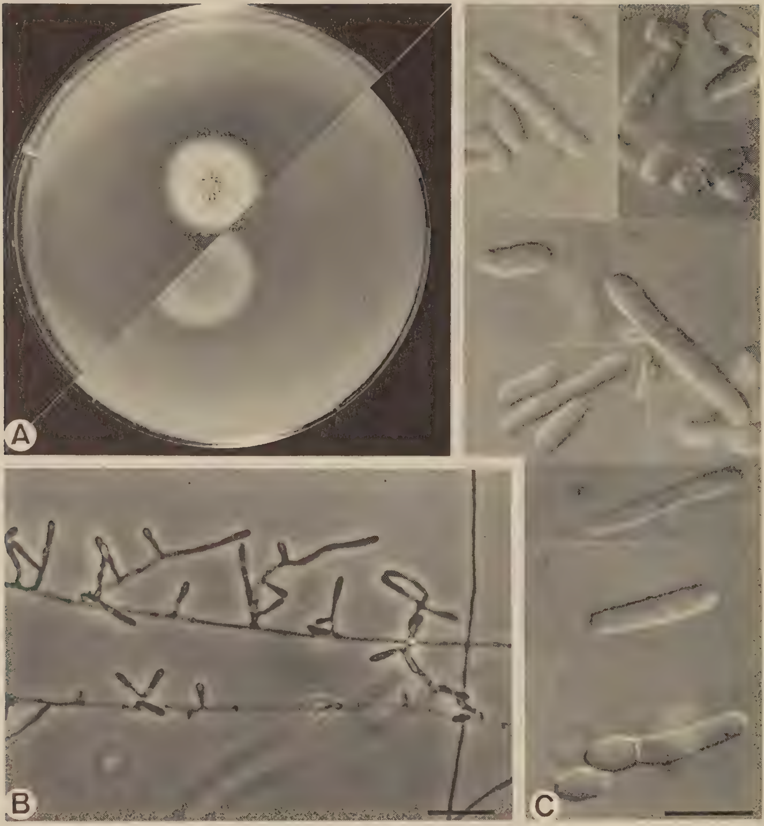

Fig.1.- ***Chrysosporium siglerae*** (FMR 3066). A, colonies on PDA at 20 d, at 25°C. B, Anamorph in microculture (Bar= 30 μm). C, conidia (Bar= 10 μm).

thallica, cylindrica usque clavata, plus minusve alternata, tunicata, levia vel leniter verrucosa, unicellularia (6.5-13 x 2-3.5 μm) vel bicellularia (5 - 30 x 2 - 3 μm); per disarticulationem hypharum vegetativarum formata. Chlamydospora absunt. Teleomorphosis ignotis.

*Holotypus: ex solo isolatus, apud Pobla de Farnesa, Castellón (Hispania), I-1987. IMI 336467 (Isotypus: FMR 3066 (**F**aculty of **M**edicine of **R**eus Collection) = UAMH 6541).*

Chrysosporium siglerae Cano et Guarro *sp. nov.* Fig.1,2.

Colonies on Phytone-Yeast Agar (PYE) attaining 10-15 mm diam in 21 days at 28°C, initially flat, margin regular and defined, pale yellow (M. 4A3; Kornerup & Wanscher, 1984) overall with the exception of a white narrow band in the marginal zone, powdery, reverse uncoloured; later raised at the centre, with radial grooves, the central part becomes felty, reverse uncoloured. **Colonies** on Sabouraud Dextrose Agar (SDA) attaining 15-20 mm diam in 21 days at 28°C; initially flat, later radially undulate in the centre, grisaceous orange (M. 5B3) with a white marginal area, later one can only observe a narrow submarginal grisaceous orange (M. 5B3) circle and the rest of the colony is white, powdery-felty, margin regular and defined; reverse initially uncoloured and later pale brown due to the production of diffusible pigments. On Potato Dextrose Agar (PDA), the cultural features are similar to those on SDA.

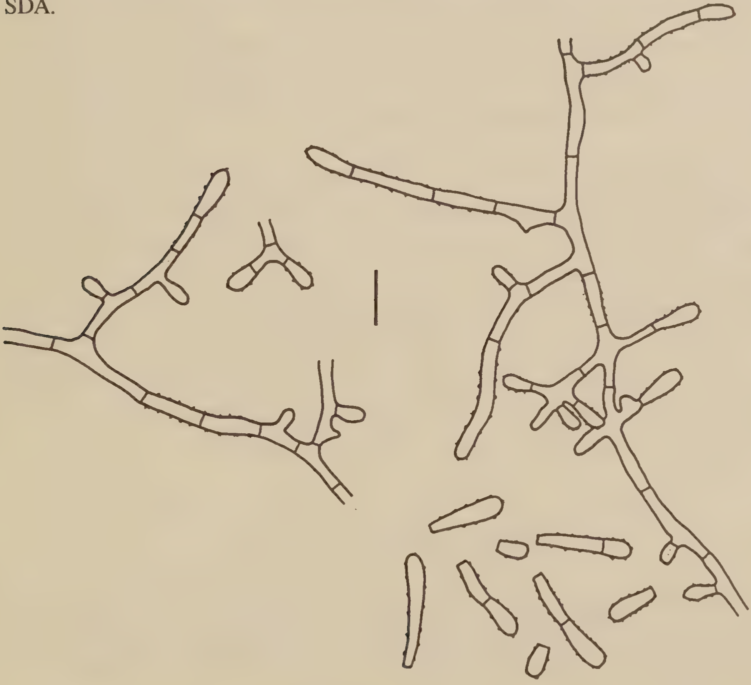

Fig. 2.- ***Chrysosporium siglerae*** (FMR 921). (Bar= 10 µm).

Vegetative hyphae hyaline, very branched and scarcely septate, smooth, 2-2.5 µm wide. Conidia thallic, mostly lateral, cylindrical to clavate, hyaline, light brown in mass, smooth to slightly verrucose, 1-celled, 5-30 x 2-3.5 µm, or frequently 2-celled, 10-16 x 2-3 µm. Intercalary conidia cylindrical, normally in series of two or more, seldom alternate, 10-15 x 2-2.5 µm.
The fungus is not inhibited by actidione (0.04%). Minimum growth at 12°C, optimum from 18-28°C, maximum 37°C.
On the natural substrate the conidia are light brown in mass.

Material examined.- Holotype: IMI 336467, garden soil, Pobla de Farnesa, Castellón, Spain, I-1987, (Isotype: FMR 3066 (Ex-type UAMH 6541)); FMR 921, forest soil, Torrepacheco, Murcia, VIII-1985.

C. siglerae is very similar to ***C. europae*** Sigler, Guarro *et* Punsola (Sigler *et al.*, 1986) by the abundance of intercalary conidia. Both species form an intermediate group between ***Chrysosporium*** and ***Malbranchea***. Because the terminal and lateral conidia are slightly wider than those of the supporting hyphae, we consider appropriate its inclusion in the former genus (Sigler *et al.*, 1986).
C. siglerae differs mainly from ***C. europae*** by the presence of bicellular conidia, absence of alternate arthroconidia which are not released immediately and colour of the colonies, which are vinaceous buff with a mahogany coloured reverse in ***C.europae***.
Another similar species is ***C. geophilum*** Kushwaha *et* Shrivastava (Kushwaha & Shrivastava, 1989), also with intercalary and bicellular conidia, but they are typically swollen. Furthermore, on Sabouraud Dextrose Agar colonies develop faster and are white. This is not observed in ***C. siglerae***. Representative cultures of ***C. geophilum*** were not available for study.

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STUDY OF TRAMETES DICKINSII BERK.SENSU AUCTS., A SYNONYM OF D. QUERCINA

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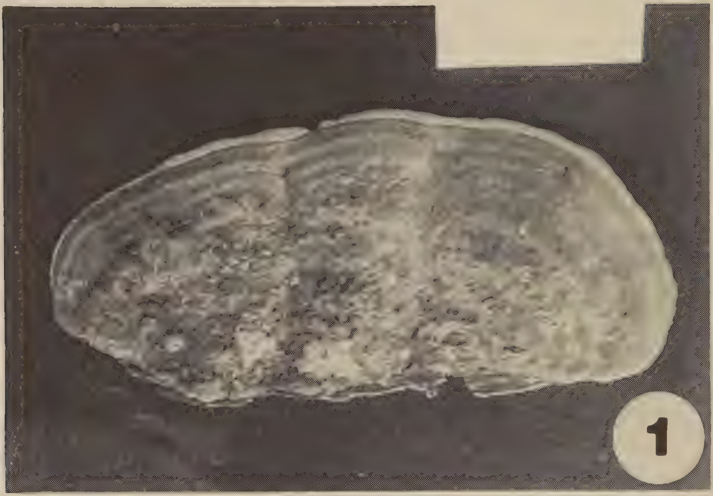
SUMMARY

Morphological,cultural and intercollection mating studies of Trametes dickinsii Berk. sensu aucts.and Daedalea quercina Fr. show these two names to be synonymous.

INTRODUCTION

Trametes dickinsii Berk.Sensu aucts is reported to occur in India and Japan (Bakshi 1971).It is known to grow also in Ajerbaizan,former USSR (personal communication with Dr.E.Parmasto of Academy of Sciences of former Estonian SSR).Recently we made several collections of this species from India and established polysporous and monosporous cultures from some of them. As not much is known about this fungus,we studied in detail its morphological and cultural characters. From our observations we were surprised by the resemblance of this fungus to Daedalea quercina Fr.,the type species of Daedalea Fr.,as described by Cunningham (1965),Domanski et al.(1973), Ryvarden (1978) and Telleria (1980). Literature also reveals that Imazeki and Toki (1954) too noticed the close similarity between these 2 species and noted that except for the pore characters"...the plant (i.e. Trametes dickinsii Berk.) is similar to D.quercina in every essential characteristics". We therefore decided to clarify the relationship of T.dickinsii to D.quercina.Sporophores of T.dickinsii collected by us and the cultures established therefrom together with some sporophores and cultures obtained from other sources were the principal study materials. As D.quercina is not reported to occur in India,sporophores and cultures of this species were procured from other sources. All these were studied critically from the morphological and cultural point of view including interfertility tests, as such studies have been suggested by many authors (Carranza - Morse & Gilbertson 1986;Macrae 1967;Nobles 1943;Nobles & Frew 1962;Sarkar 1959) to be a useful tool in the clarification of the taxonomic position of higher fungi. The results are presented herein.



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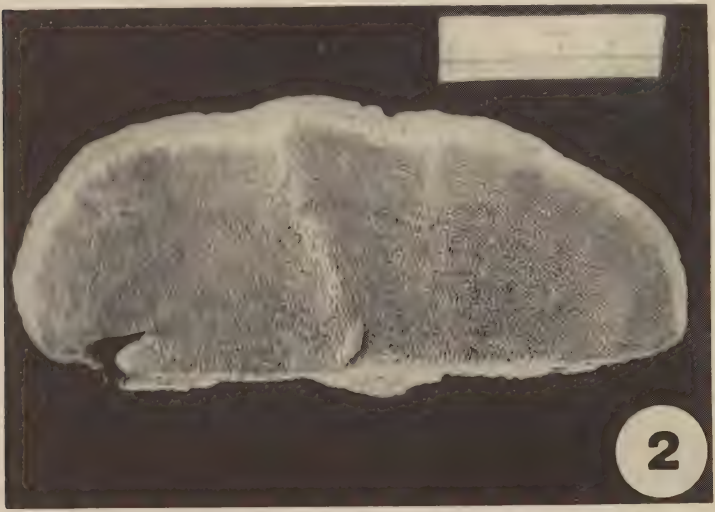

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Figs.1-2.*Trametes dickinsii*. 1.Upper surface of basidiocarp. 2.Hymenial surface of basidiocarp.

description. In the present paper detail morphological and anatomical characters of *Stereum plicatulum* Lloyd has been provided based on the Indian collection made by the author.

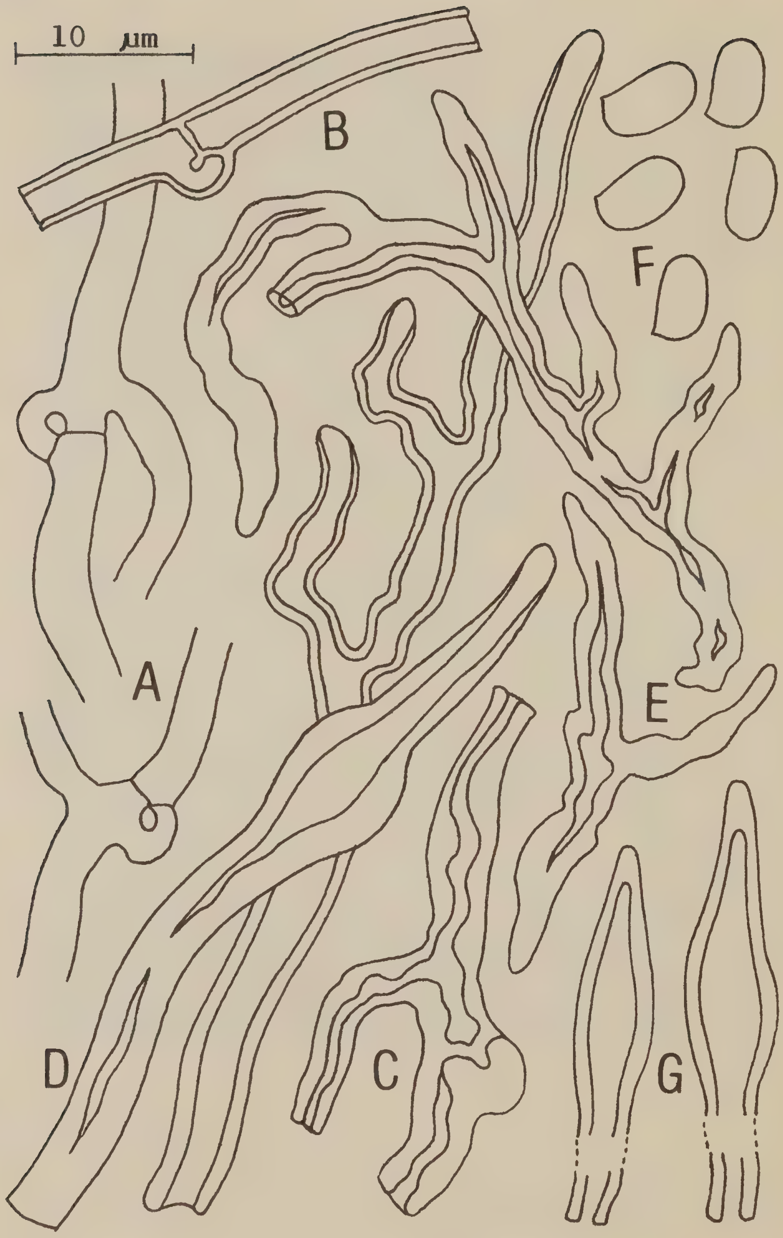
Stereum plicatulum Lloyd
Mycol.Writ.7 Mycological Notes No.67:1157.

Basidiocarp (Figs.1 & 2) effused-reflexed, tough when fresh, hard on drying, usually up to 680 µm thick; pileus narrowly reflexed to flabelliform, often lobed and wavy, at first finely adpressed tomentose to velutinate, smooth to the eye, soon becoming glabrous, tawny, generally zonate; margin thinning or acute, concolourous, involute, especially when dried;context hyaline to yellowish; hymenial surface smooth, crisped and folded radially, yellowish or pale orange.
Hyphal system dimitic. Generative hyphae (Fig.3) hyaline, thin-walled, simple-septate, branched, irregularly wide, 2.4-3.6 µm in diam. bearing narrower branches of 1.2-1.8 µm diam.; skeletal hyphae (Fig.4) hyaline, thick-walled to solid, often with secondary septa, usually unbranched,occasionally with 2-3 apical branches,apex variable,some thin-walled, others thick-walled and slightly constricted a little below the tip,2.4-4.8 µm in diam.; basidia (Fig.5) hyaline, thin-walled, clavate, 13.8-15.6 X 2.4-3.0 µm, bi- and tetrasterigmatic,sterigmata 2.4-3.6 µm long;basidiospores (Fig.6) hyaline,thin-walled,smooth,ellipsoid,4.8-6.0 X 1.8-2.4 µm, uniguttulate, apiculate,amyloid,acyanophilous;skeletocystidia (Fig.7) abundant, arising from the trama and forming a fairly dense layer next to the hymenium,smooth,thick-walled but apically thin-walled,hyaline to subhyaline and with granular to oily contents, 4.8-6.0 µm wide.

TYPE OF ROT: White rot.

SPECIMEN EXAMINED: BRCMH TA-6,Zero,Arunachal Pradesh,India,5754 ft. above sea level,on dead branch of an unknown angiosperm, 23.X.1981. Kept in the (BRCMH) Mycological Herbarium,Department of Botany,Burdwan Raj College, Burdwan,West Bengal,India. A portion of the specimen has been deposited in the Kew Herbarium, Richmond, Surrey, England [K(M):24729].

Figs.1. & 2. *Stereum plicatulum*: 1. upper surface of basidiocarp; 2. hymenial surface of basidiocarp.


10 μm
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wood brown, 0.5-1.0 cm thick; hymenophore pinkish brown to wood brown, pores round to angular, frequently labyrinthine, 1-3 per mm, pore tubes brown.

Hyphal system trimitic. Generative hyphae branched, clamped, thin-walled to thick-walled, frequently walls irregularly thickened, 1.8-4.0 µm wide. Skeletal hyphae predominant, hyaline to subhyaline, thick-walled to solid, unbranched, rarely branched at the apex, 2.5-5.2 µm wide, sometimes distally swollen to 6.5 µm. Binding hyphae hyaline to subhyaline, thick-walled to solid, shortly branched, 1.2-2.5 µm wide, few in number and occurring only in the pore field. Basidia clavate, 4-sterigmate, 6.5-10.0 x 3.5-4.5 µm. Basidiospores hyaline, thin-walled, short cylindric or ellipsoid-cylindric, smooth, apiculate, 5.5-6.5 x 2.5-3.5 µm. True cystidia lacking, but terminal ends of tramal skeletal hyphae project into the pore tubes to form cystidioid hyphae.

ROT: Brown rot.

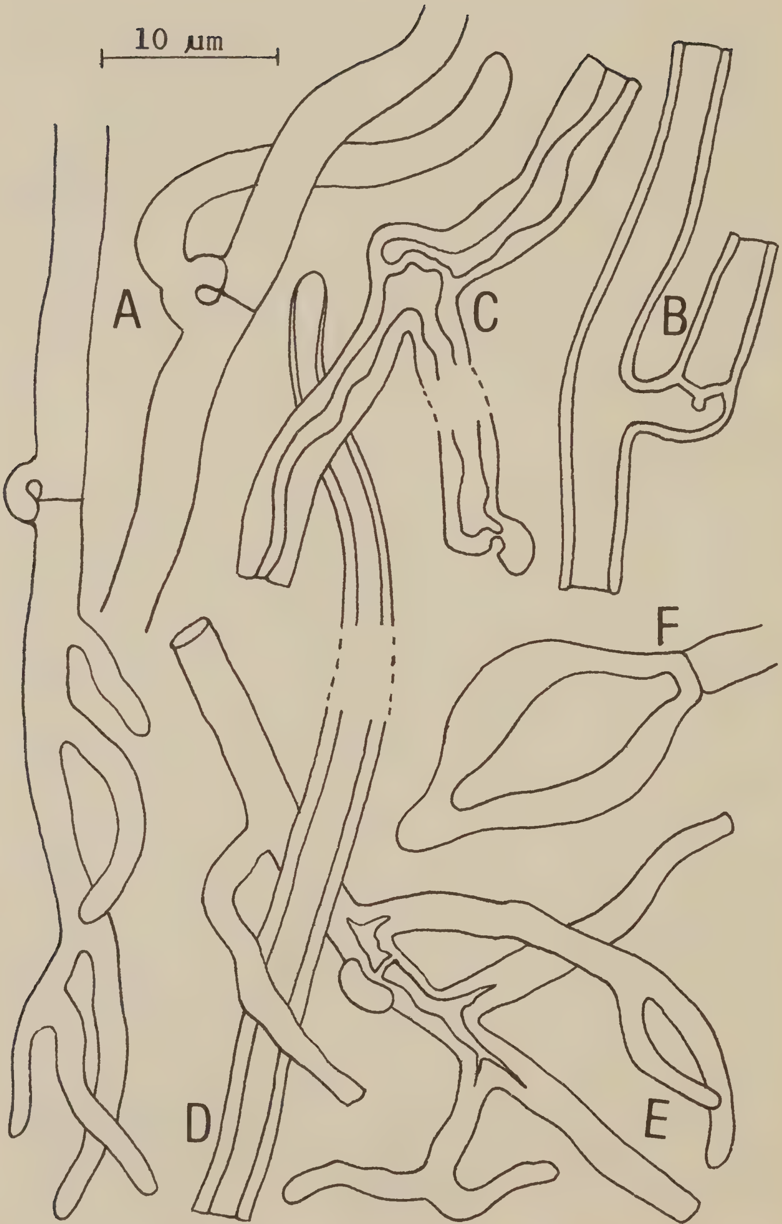
CULTURAL CHARACTERS:

Growth characters :Growth moderately rapid, covering the plate in 4 weeks. Advancing zone even or slightly bayed, mycelium extending to the margin; mat white, woolly-floccose, more dense in the newer growth, finely zonate in the older part, soon becoming woolly-felty with a band of narrow raised woolly-felty zone just behind the advancing zone; thin to thick white mycelium from around the inoculum spreading along the edges of the bottom and on the lid of the petridish. Reverse unchanged. Oxidase reaction negative on both gallic acid and tannic acid agar media.

Hyphal characters: Advancing zone - hyphae hyaline, thin-walled, branched, septate, with bulging clamp connections, often with medalions and staghorn branching, 1.8-4.4 µm wide.

Aerial mycelium - (a) hyphae as in advancing zone but broader, up to 5.2 µm; (b) hyphae hyaline, with clamp connections, thick-walled, thickening frequently irregular, often broken at clamps, occassionally showing H-connections, 2.6-6.0 µm; (c) fibre hyphae abundant, hyaline, thick-walled to solid, unbranched or branched, the latter often showing clamp connections, sometimes broken at clamps, 1.5-3.5 µm wide; (d) chlamydospores many, hyaline, highly thick-walled, terminal or intercalary, elliptical, pear shaped or ovoid, 14-20 x 9-13 µm.

Fig.3. A-G. Microscopic structures from basidiocarp of *Trametes dickinsii*. A. Thin-walled generative hyphae. B. Thick-walled generativt hypha. C. Irregularly thick-walled generative hypha. D. Skeletal hyphae. E. Binding hyphae. F. Basidiospores. G. Cystidioid hyphae.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Daedalea quercina (L.):Fr.,Syst.Myc.1,333,1821.

Collections studied : DAOM 142475** ; TAA 125541,52950; CFMR 1762*,1764* ;
BS 221.61*,230.67** .

Detailed macro- and micromorphological descriptions of *D.quercina* have been given by many workers including Cunningham (1965), Domanski et al. (1973),Ryvarden (1978),Telleria (1980) with which the present observation agrees broadly. A redescription is therefore unnecessary.

Cultural characters of this species published by Nobles (1948,1965), Stalpers (1978) and Westhuizen (1971) are also practically similar to those noted by the present authors; but the presence of branched fibre hyphae with clamp connections which are often broken at clamps and occur in felty areas of the mat were not recorded by earlier workers.

ROT: The species is reported to cause brown rot (Nobles 1965).

INTERFERTILITY STUDIES: The result of pairing 15 monosporous cultures of single basidiocarps of *T.dickinsii* (VBMH 831101 and 831102) showed a typical pattern of bipolar sexuality. Compatibility was also noticed when the two mating types of each of these two isolates were paired amongst themselves indicating thereby that the paired isolates were conspecific and that compatibility was determined by multiple allelomorphs.

Pairings of monokaryotic mycelia of the aforesaid 2 isolates of *T.dickinsii* and *D.quercina* obtained from other sources (CFMR H-379, 380, 381;DAOM 2278-2,4,5) were also completely compatible. The result of pairing experiments is given below:

T.dickinsii VBMH 831101	*T.dickinsii* VBMH 831102
A1 : 1,3,4,6,9,11,12,15	A3 : 2,3,6,7,10,14,15.
A2 : 2,5,7,8,10,13,14	A4 : 4,5,8,9,11,12,13.

T.dickinsii 831101	-1 x	*D.quercina*	H-379	+
	-2 x		H-380	+
	-5 x		H-381	+
831102	-3 x		2278-2	+
	-6 x		2278-4	+
	-9 x		2278-5	+

Fig.4. A-F. Microscopic structures from culture of *Trametes dickinsii*. A. Thin-walled clamped hyphae with medalion and staghorn type of branching. B. Thick-walled clamped hypha. C.Clamped hypha with irregular wall thickening. D. Unbranched fibre hypha. E. Branched fibre hypha. F.Chlamydospore.

DISCUSSION

The present observation on the collections of T.dickinsii and D.quercina indicates that microscopically all the basidiocarps are identical. They have similar types of hyphae and basidiospores. Microscopically the hymenial surface of T.dickinsii differs slightly from that of D.quercina in that in the former, the hymenial surface has not been found to be lamellate while in the latter, the hymenophore is poroid to daedaloid to lamellate.

But according to modern concepts of taxonomy configuration of hymenial surface is not an important taxonomic criterion.

All the cultural isolates are also similar having the same texture and same microscopic characters. Other common characters of the two species which are worth mentioning are the absence of extracellular oxidase, association of basidiocarps with brown rots and bipolar sexuality.

The interfertility between all isolates indicates that they belong to one species.

Foregoing evidences from morphological, cultural and intefertility studies establishes that the fungus labelled Trametes dickinsii in India is D.quercina..

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NEW SPECIES and NEW COMBINATIONS in the LICHEN GENUS PHYSCONIA in NORTH AMERICA

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ABSTRACT: Four new species in the lichen genus *Physconia* are described from North America. *Physconia americana* Essl. from western North America, and *Ph. subpallida* Essl. from eastern North America, are primary species which had previously been mistaken for *Ph. distorta* (With.) Laundon. The other two species are both from western North America: *Ph. thomsonii* Essl. is a sorediate species resembling and previously mistaken for *Ph. grisea* (Lam.) Poelt and *Ph. elegantula* Essl. is an isidiate species. Two new combinations are also made: *Ph. leucoleiptes* (Tuck.) Essl. and *Ph. isidiigera* (Zahlbr. in Herre) Essl.

The North American representatives of the lichen genus *Physconia* have received very little critical attention since the work of Thomson (1963) thirty years ago. As with most poorly studied lichen genera, authors have generally simply adopted the names of whichever European taxa seem to be the closest fit. During the course of my revisionary studies on the genus, a number of previously unknown or badly misunderstood species have been discovered for North America, and these are presented below. More complete data on these and the other North American species are still being gathered and will be presented later. The chemical data reported have been obtained using the standardized thin-layer chromatography techniques derived by Culberson and Kristinsson (1970) and its modifications (Culberson 1972; Culberson & Ammann 1979).

PHYSCONIA AMERICANA ESSL. sp. nov. (Fig. 1)

Thallus foliaceus, usque ad 8 cm diametro, superne griseus vel fuscus et plus minusve pruinosus; sorediis isidiisque destitutus; subtus ater, rhizinis squarroso-ramosus. Differt a *Physconia distorta* stratum corticale superiorus paraplectenchymatum.

Thallus gray-brown to brown, often with a more or less complete pruina or the pruina sometimes best developed on the lobe ends and apothecia (including disks, margins, and lobules), up to 8 cm in diameter, usually more or less orbicular. Lobes linear and discrete to somewhat irregular-flabellate and confluent to weakly overlapping, 1-2 mm broad, ± flat. Without soredia or isidia, only occasionally developing sparse to rather abundant lobules centrally. Medulla white. Lower surface pale tan to pale brown on the lobe-ends, soon dark brown or black inward, dull to weakly shiny; rhizines black, squarrosely branched. Apothecia frequent and nearly always present, up to 3 mm in diameter, sessile, the margin entire or more usually developing lobules ; spores 30-36 x 15-19 μ m, *Physconia*-type. Thallus 150-260 μ m thick; upper cortex paraplectenchymatous-mesodermatous, 25-50 μ m thick; lower cortex irregularly prosoplectenchymatous, 15-35 μ m thick.

Chemistry: no lichen substances detected; medulla K-, KC-.

Type: Idaho. Kootenai Co.: near the south end of Lower Twin Lake; Douglas fir forest at ca. 760 m elev., on creekside cottonwood near road, 3 July 1990, *Esslinger 11344* (DUKE, holotype; GZ, herb. Essl., isotypes).

Distribution: on bark or rock; presently known from Idaho, Washington, Oregon, and California, but probably somewhat more widely distributed in western North America.

This species has been generally referred to as *Ph. distorta* or one of its synonyms (e.g. *Ph. pulverulenta* or *Ph. pulverulacea*). The two are very similar in basic characters and they exhibit similar degrees of morphological variation. The major difference between the two species is the tissue type of the upper cortex: paraplectenchymatous in *Ph. americana* and scleroplectenchymatous in *Ph. distorta*. The tissue type of the upper cortex in species of *Physconia* is a consistent and species-specific character (Poelt 1966; Moberg 1977). It now appears that actual *Ph. distorta* may not occur in North America at all (see discussion of *Ph. subpallida* below).

PHYSCONIA ELEGANTULA **ESSL. sp. nov.** (Fig. 2)

Thallus foliaceus, usque ad 7 cm diametro, superne griseo-fuscus vel fuscus et plus minusve pruinosus, isidiatus; isidiis sparsis vel frequens, cylindricis; subtus albus vel pallido-fulvus, rhizinis squarroso-ramosus, nigrescens.

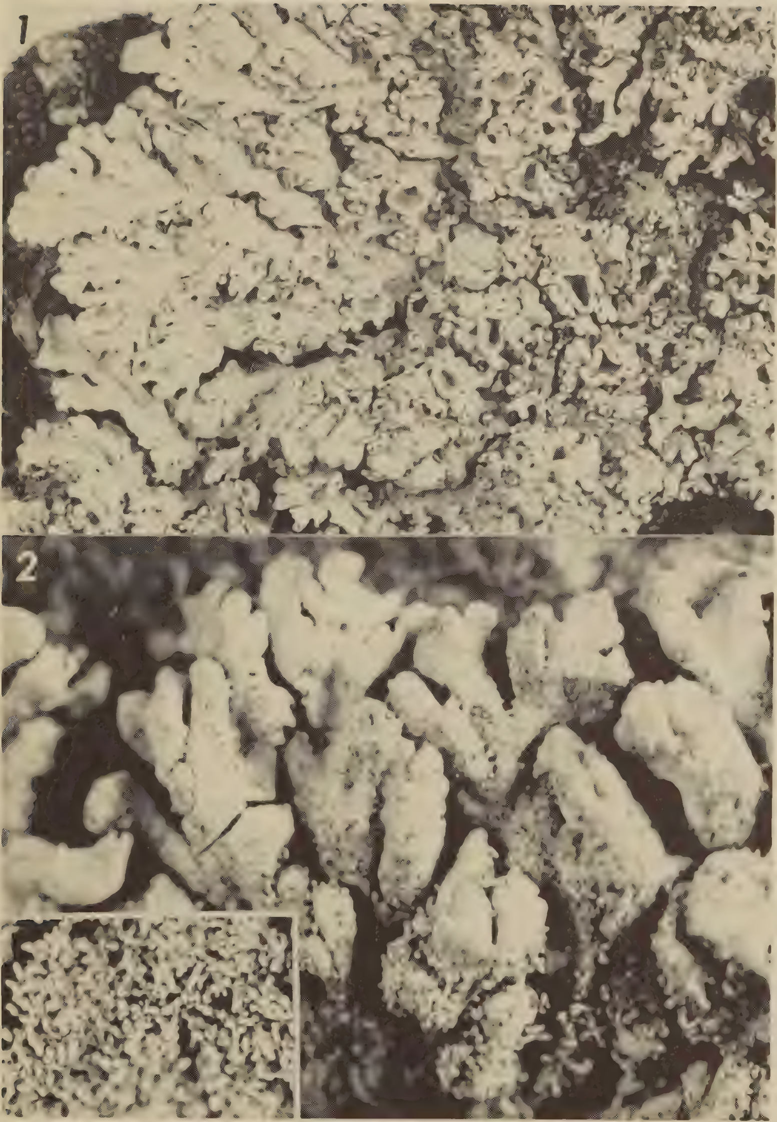
Thallus gray-brown to brown, usually with a more or less complete pruina, up to 7 cm in diameter, orbicular to somewhat irregular. Lobes linear and discrete to somewhat irregular-flabellate and confluent to partly overlapping, 0.8-2 mm broad, ± flat to irregularly concave. Isidiate, the isidia sparse to abundant but often unevenly so, arising as spherical papillae, becoming cylindrical-coralloid and some eventually growing into flat lobules. Medulla white. Lower surface white to pale tan, darkening only in old necrotic parts of the thallus or not at all, dull to weakly shiny; rhizines soon blackening, squarrosely branched. Apothecia frequent, up to 3 mm in diameter, sessile, the margin becoming crenate and eventually unevenly isidiate-lobulate; spores 27-36 x 12-17 μ m, Physconia-type. Thallus 150-210 μ m thick; upper cortex scleroplectenchymatous, 25-50 μ m thick; lower cortex irregularly prosoplectenchymatous, 25-28 μ m thick.

Chemistry: no lichen substances detected; medulla K-, KC-.

Type: Arizona. Coconino Co.: Kaibab National Forest just south of Grand Canyon National Park along Highway 64: pinyon-juniper woodland at ca. 2,040 m, on rock, 19 Jan 1989, *Esslinger 11095* (DUKE, holotype; GZ, herb. Essl., isotypes).

Distribution: on rock; presently known from Wyoming, Utah, Colorado, New Mexico and Arizona.

This very distinctive species should not be easily confused with any other in North America. The propagules of this species are true isidia, developing as such from the start and not from soredia. The isidioid soredia found on extreme spec-



Figs. 1-2. *Physconia* type specimens. **Fig. 1.** Part of the holotype specimen of *Ph. americana* (*Esslinger 11344*, DUKE), x 3.5. **Fig. 2.** Part of the holotype specimen of *Ph. elegantula* (*Esslinger 11095*, DUKE), x 9. The small inset shows mature isidia in the central part of a thallus.

imens of *Ph. isidiigera* (see below) and a few other species can closely resemble isidia, but their origin as soredia can usually be deduced by their clustered, marginal arrangement and by examination of younger thallus areas to observe their ontogeny.

PHYSCONIA ISIDIIGERA **(ZAHLBR. in HERRE) ESSL. comb. nov.**

Basionym: *Physcia pulverulenta* subsp. *isidiigera* Zahlbr. in Herre, Proceedings of the Washington Academy of Sciences 7: 362. 1906. Type: California: Mayfield, on old roof, 24 Mar 1904, *Herre 365* (F, FH, NY, isotypes).

Synonym: *Physcia isidiigera* (Zahlbr. in Herre) Fink, Lichen Flora of the United States, p. 387. 1935.

The holotype specimen, which according to the protologue was orignally deposited in the Stanford University Herbarium (now at CAS?), has not yet been located. The isotypes cited above ("cotypes" in the protologue) contain abundant material however, and are uniform and distinctive.

Herre's type collection actually represents a rather extreme form of the species. This species is characterized by more or less elongate, marginal soralia, which are sometimes weakly reflexed in part, but not at all labriform. The soredia are granular in most cases, but not infrequently they become pseudocorticate and sometimes strongly isidioid (as in the type collection). The specimens with ecorticate, granular (non-isidoid) soredia have been often mistaken for *Ph. detersa*, but the latter species is characterized by a scleroplectenchymatous upper cortex whereas the upper cortex of *Ph. isidiigera* is distinctly paraplectenchymatous. Among the several hundred sorediate specimens of *Physconia* examined from western North America, none have turned out to be *Physconia detersa*. In addition to *Ph. isidiigera*, another common sorediate species that occurs in western North America is *Ph. enteroxantha* (Nyl.) Poelt which can be distinguished by a pigmented medulla (pale yellow to almost white, see discussion of *Ph. leucoleiptes*) which reacts K+ yellow (sometimes slight in specimens with faint pigmentation) and KC+ yellow-orange (sometimes slight but always detectable).

PHYSCONIA LEUCOLEIPTES **(TUCK.) ESSL. comb. nov.**

Basionym: *Parmelia pulverulenta β. leucoleiptes* Tuck., Proceedings of the American Academy of Arts and Sciences 1: 224. 1847. Type: Cambridge, Massachussets, 1837, *Tuckerman* (FH-Tuck., lectotype, selected by Moberg, 1977).

Synonym: *Physcia leucoleiptes* (Tuck.) Lettau, Hedwigia 7: 254. 1912.

In the past this species has been considered to be synonymous with *Physconia detersa* (Nyl.) Poelt (Zahlbruckner 1931; Moberg 1977) but the two are both morphologically and chemically distinct. The most distinctive characteristic of this species is the form of the soralia, which are marginal and terminal on short lateral branches (rarely laminal also in older parts), and which become more or less labriform as the lobe tip or edge becomes reflexed, often rather strongly. The soralia sometimes remain quite discrete, but even when they become essentially continuous along the lobe margins, the individual labriform soralia are usually still obvious. By contrast, the soralia of *Ph. detersa*, which, like *Ph. leucoleiptes*, is also common in much of eastern North America, are marginal and mostly continuous, linear to sometimes rather curved or crisped. The edges are somtimes weakly reflexed, but are not strongly labriform as in *Ph. leucoleiptes*. In addition, the soralia of *Ph. leucoleiptes* are usually distinctly K+ dingy yellow-orange, and even more distinctly KC+ orange. The soralia of *Ph. detersa* do not react with K or KC (but see discussion below of *Ph. enteroxantha*).

The apothecia of *Ph. detersa* and *Ph. leucoleiptes* are also different in form, although since both are sorediate species, apothecia occur infrequently (but not rarely). In *Ph. detersa*, the apothecia eventually develop soredia directly on the margins, which almost never become lobulate. In *Ph. leucoleiptes*, the apothecial margins normally develop distinctive radiating lobules, which in turn eventually develop more or less labriform soralia at their ends.

The medulla of *Ph. leucoleiptes* is white and K-, KC-. Rarely, however, the medulla in older parts of the thallus (especially in the vicinity of soralia) will react K+, KC+ like the soralia, a reaction which could cause some confusion with *Ph. enteroxantha*. In *Ph. enteroxantha* the medulla is normally pigmented pale yellow, although it varies to off-white or even white in occasional specimens with a low pigment concentration. Nevertheless, the medulla of *Ph. enteroxantha* is consistently K+ yellow (sometimes pale) and distinctly KC+ yellow-orange, even in essentially white parts of the medulla or parts near the lobe tips. The soralia of *Ph. enteroxantha* are not labriform like those of *Ph. leucoleiptes*, but are essentially marginal and linear to somewhat undulate, more like those of *Ph. detersa*. They sometimes react K+ and KC+ like the medulla but almost as often they are K- and KC-. The pigment in the medulla of *Ph. enteroxantha* has been identified as secalonic acid A (Kümmerling 1991), and this same substance is responsible for the positive spot tests on the soralia of *Ph. leucoleiptes* (even though the soralia are not usually noticeably yellow in color). Because of the often strongly labriform soralia, this species has sometimes been misidentified as *Ph. perisidiosa* (Erichsen) Moberg, but that species is easily distinguished by the peripherally ecorticate lower surface which usually develops distinctive blackened striations.

The lectotype specimen selected by Moberg (1977) is not entirely homogeneous. It consists of seven thalli (or parts/groups of thalli) glued to a large card inside a packet. Six of these represent *Ph. leucoleiptes*, but the largest piece, at the top in the middle, is a specimen of *Ph. kurokawae* Kashiwadani. Although it can't be removed physically, this piece should be considered to be excluded from the lectotype of *Ph. leucoleiptes*. *Physconia leucoleiptes* is essentially morphologically identical to *Ph. kurokawae* which is distinguished by its production of gyrophoric acid in the medulla and the resulting C+ rose and KC+ rose-red spot tests. These spot tests often fade rather fast and in some specimens can be observed only in the lower part of the medulla, adjacent to the lower cortex. The soralia of *Ph. kurokawae* contain secalonic acid A and therefore give spot tests like those of *Ph. leucoleiptes*. Based on the descriptions and comparisons of Kashiwadani (1975), the specimens of *Ph. detersa* reported from Japan probably all represent *Ph. leucoleiptes*.

***PHYSCONIA SUBPALLIDA* ESSL. sp. nov.** (Fig. 3)

Thallus foliaceus, usque ad 8 cm diametro, superne griseo-fuscus vel brunneus, plus minusve pruinosus; sorediis isidiisque destitutus; subtus albus vel pallido-fulvus, rhizinis squarroso-ramosus, nigrescens.

Thallus gray-brown to dark brown, usually with a more or less uniform gray pruina, up to 8 cm in diameter, orbicular, sometimes becoming panniform due to the development centrally of many elongate, marginal (and some laminal) lobules. Lobes elongate and discrete to somewhat irregular-flabellate and partly overlapping, 1-2.5 (-3) mm broad, ± flat to irregularly convex. Without soredia or isidia, but

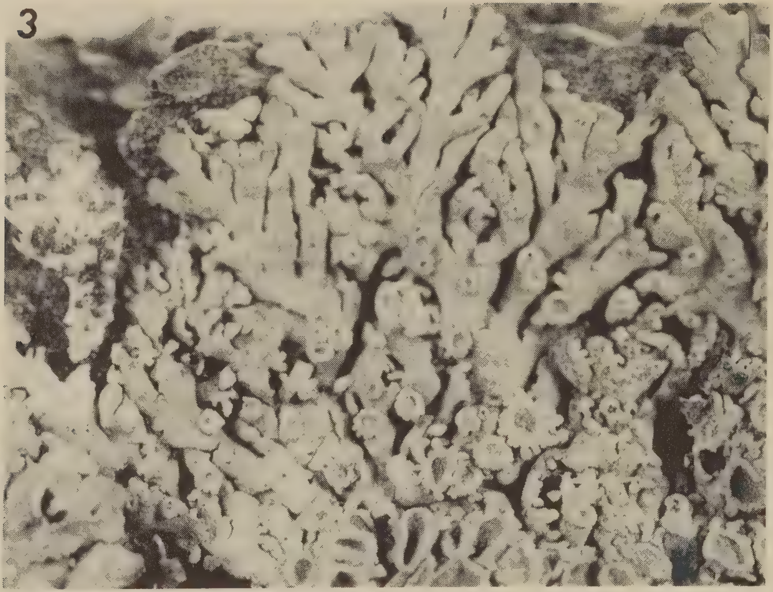

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Fig. 3. Part of the holotype specimen of *Physconia subpallida* (*Griffin 77*, FH), x 5.5. Note the small piece on the upper left side which is turned upside down showing the pale lower surface.

often with more or less well-developed lobules in central parts of the thallus. Medulla white to off-white. Lower surface pale tan to almost white in part, with only occasional darkened areas, these usually appearing necrotic; rhizines soon blackening and becoming squarrosely branched. Apothecia common (but sometimes absent, especially in more densely lobulate forms), up to 5 mm in diameter, sessile, the margin becoming lobulate, sometimes densely; spores 28-37 x 15~~-17~~ (-20) um, Physconia-type. Pycnidia blackening, flush to slightly emergent, conidia 3-4 x 1 μ u, more or less cylindric or sometimes slightly larger toward one end. Thallus 200-290 μ m thick; upper cortex scleroplectenchymatous, 33-76 μ m thick; lower cortex prosoplectenchymatous, 25-30 μ m thick, indistinctly delimited from the medulla.

Chemistry: no substances detected; medulla K-, KC-.

Type: Vermont. Chittenden Co.: Lake Champlain, Malletts Bay, on elm, 21 Mar 1910, *D. B. Griffin 77* (FH, holotype).

Distribution: on bark of hardwoods, less often on rock; presently known by me from Illinois, Iowa, Ohio, New Jersey, Massachusetts, Vermont, and southern Ontario, but undoubtedly somewhat more broadly distributed in eastern North America.

Like *Ph. americana,* this eastern North American taxon has generally gone by the name of *Physconia distorta* (or one of its synonyms). Apparently because of the very pale lower surface of this eastern species, Hale (1979) confused it with *Anaptychia palmulata* (Michaux) Vain., which can be easily distinguished from the present species by the pale to dark brown, epruinose thallus (though sometimes with scabrose lobe-ends), the simple to fasciculate rhizines, the apothecia with pale to dark brown epruinose disk, the generally larger spores, and a distinctly prosoplectenchymatous upper cortex. Also, the apothecia of *A. palmulata* usually bear few or no centrifugal lobules on the exciple, which instead becomes crenate as the apothecia mature, with the individual crenations sometimes growing into small centripetal (inward pointing) lobules.

Wong and Brodo (1992) noted the pale lower surface of this eastern *Physconia*, and suggested a possible relationship to the Eurasian species, *Ph. venusta*. The latter species, however, has a peripherally ecorticate lower surface with fine black striae, essentially like the lower surface of the common sorediate species *Ph. perisidiosa*.

PHYSCONIA THOMSONII **ESSL. sp. nov.** (Figs. 4 & 5)

Thallus foliaceus, usque ad 5 cm diametro, superne grise-fuscus, pruinosus, sorediatus, soraliis marginalibus et terminalibus, labiatis; subtus albus vel pallido-fulvus, rhizinis simplicibus vel furcatus, albus vel pallido-fulvus.

Thallus gray-brown, with a more or or less complete pruina, up to 5 cm in diameter, irregular to somewhat orbicular. Lobes mostly irregular-flabellate, ± contiguous to slightly overlapping,1-2 mm broad, ± flat at the tips but mostly becoming convex inward. Sorediate, the soralia primarily marginal and terminal (but not on the peripheral lobes), becoming labriform; individual soredia coarsely granular, mostly becoming distinctly darkened to almost black. Medulla white. Lower surface almost white on the lobe tips, inward becoming pale tan to deep tan; rhizines scattered, simple to irregularly furcate (but definitely not squarrose), conclorous with the lower surface.. Apothecia not seen. Pycnidia infrequent, dark brown to blackened and flush with the surface; conidia 5-6 x 1 μm, cylindrical (a few becoming slightly bent). Thallus 270-300 μm thick; upper cortex scleroplectenchymatous, 20-56 μm thick; lower cortex very thin and poorly organized, intergrading with the medulla.

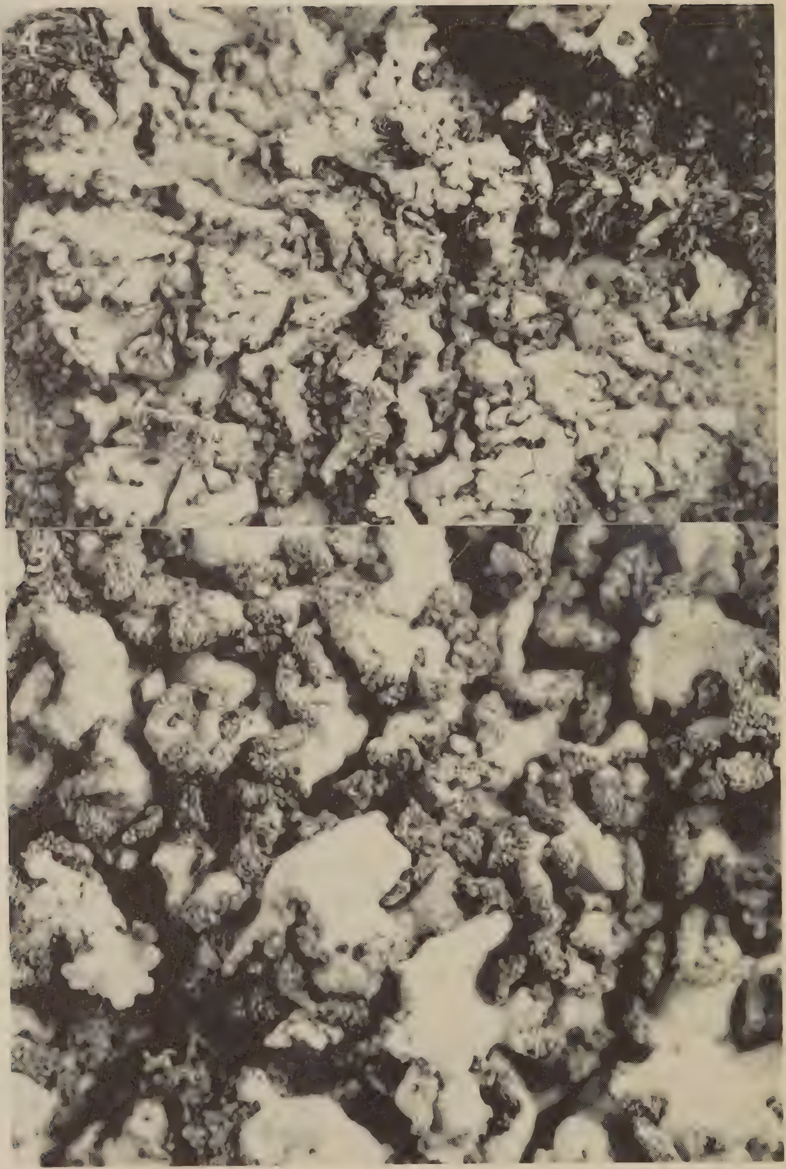
Chemistry: unidentified terpenoid; medulla and soralia K- and KC-.

Type: Colorado. Mesa Co.: vicinity of Grand Junction, ca. 10-12 miles NNE of Fruita, in Coal Creek Canyon, *Juniperus-Artemisia* habitat, on shaded rock, 9 August 1984, *Esslinger 9447* (DUKE, holotype; GZ, herb. Essl., isotypes).

Distribution: on rock; at present known only from Colorado, Idaho, and Utah.

This species is one of the most distinctive members of the genus in North America. So far, it is the only North American species of the genus that has non-squarrose rhizines. The pale lower surface and simple rhizines give this species a very superficial resemblance to some forms of the common and variable Eurasian species, *Ph. grisea*, which however is not closely related since it has a paraplectenchymatous upper cortex.

Upon close examination, occasional specimens can be observed to bear sparse and very small cortical hairs on the ends and edges of some lobes. These are almost invisible under the dissecting scope, being only about 10-15 μm long and are partly obscured by the pruina, and are therefore likely to be overlooked. They are short and tapered and reminiscent of (though much sparser and smaller than) the hairs on the lobes of *Anaptychia ulotrichoides* (Vainio) Vainio. The latter species occurs in similar habitats with *Ph. thomsonii* (including at the type locality), but is easily distinguished by its lack of soredia and its prosoplectenchymatous



Figs. 4-5. Part of the holotype specimen of *Physconia thomsonii* (*Esslinger 9447*, DUKE). Fig. 1. Most of a single thallus, showing lobe configuration, etc., x 3.5. Fig. 5. Older, central part of a thallus showing mature soralia, x 9.

upper cortex, among many other differences. Similar but usually much better developed cortical hairs are known from the European species, *Ph. servitii*, which is a fertile, esorediate taxon (Poelt 1966).

This species is named in honor of Dr. John Thomson, in recognition of his pioneering work with the North American Physciaceae.

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ON THE CHEMISTRY AND DISTRIBUTION OF CLADONIA PETROPHILA

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ABSTRACT: The recently described species, *Cladonia petrophila*, which was reported to contain perlatolic acid, actually produces the infrequently reported lichen substance sphaerophorin. This substance is presently known from only one other species of *Cladonia* and a handful of other lichen taxa.

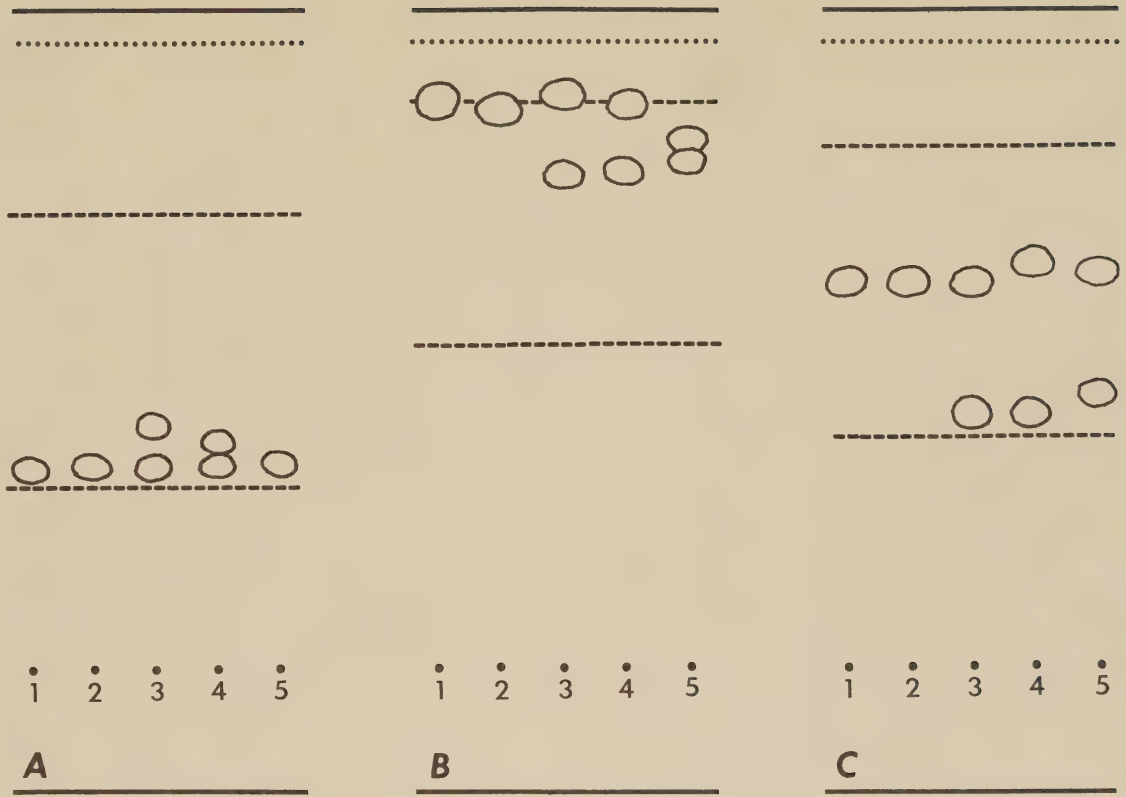
In 1972, while I was a graduate student at Duke University, I received a small shipment of lichen specimens for identification from Dr. Doyle Anderegg of the University of Idaho. Among these were a small number of *Cladonia* specimens collected in Ohio which consist only of sterile, epodetiate squamules. Preliminary attempts at determination of these specimens based on their morphology and spot tests proved unsuccessful and so a study of their secondary chemistry was undertaken, using thin-layer chromatography (TLC). Initial TLC results, using the standard three solvent systems developed by Culberson and Kristinsson (1970), indicated that one of the major constituents (along with fumarprotocetraric acid and lesser amounts of atranorin) was possibly stenosporic or perlatolic acid, two compounds with which I was very familiar from my thesis work on the brown *Parmeliae*. I also knew, however, that there are a number of other depsides that are chromatographically very similar to these two, in particular imbricaric acid and sphaerophorin and, to a lesser extent, also divaricatic acid. In fact, in her paper elaborating upon the standardized TLC techniques, Culberson (1972) used this very set of compounds as an example to demonstrate the usefulness of the technique of microhydrolysis, in which depsides are split into their two component phenolic units (the A- and the B-ring) using H_2SO_4. These five depsides have more or less similar (and in some cases identical) Rf values in the standard three solvent systems, but their individual hydrolysis products are easily distinguished by TLC. The hydrolysis procedure fully described in that paper is a very useful but relatively simple procedure, even for non-chemists, for distinguishing between compounds within various sets of depsides with very similar Rf values.

Further study of the major constituent in the sterile *Cladonia* specimens, using TLC comparison with known compounds both whole and hydrolyzed, soon led to the conclusion that it was neither perlatolic nor stenosporic acid, but sphaerophorin instead. At that time sphaerophorin was regarded as a rare compound, having been reported only from its namesake genus, *Sphaerophorus*, which is unrelated to *Cladonia*. Because of the unique chemistry and distinctive morphology, I believed these *Cladonia* specimens might represent a previously undescribed species. However, even though further specimens were borrowed from Doyle Anderegg, no collections with podedia or apothecia were found. I therefore put all the specimens aside, intending someday to come back to the problem, and hopefully locate fertile material so that the identity could be determined. Many years have passed now, and as sometimes happens, I only recently found time and impetus to return to the material.

Very recently, Harris (1992) described a new species, *Cladonia petrophila*, which often occurs primarily as epodetiate squamules. I was particularly interested, therefore, when I saw that he reported this species to produce perlatolic acid (along with fumarprotocetraric, ± atranorin). Unfortunately, Harris gave no details of his chemical analysis, but only the indication that it was done by "TLC analysis." No references on chemical technique were cited and no indication was given of the type or number of solvent systems or other methods used, therefore making it difficult to assess the likelihood that he had mistaken sphaerophorin for perlatolic acid. Based on his description of the morphology and ecology of the new species, it seemed likely that it was the same taxon I had studied and put aside years before.

In order to determine whether the two are identical, I arranged to borrow a number of the specimens cited in the protologue, including one of the isotype specimens, for study and chemical analysis. These specimens have now been analyzed, and many of Anderegg's original specimens have also been re-analyzed using the more current modifications of the three solvent system technique for TLC (e.g. Culbeson & Ammann 1979, Culberson et al. 1985), and I can now confirm that they contain sphaerophorin instead of perlatolic acid. They also contain fumarprotocetraric acid and a variable amount of atranorin which is sometimes missing or at least indetectable. In addition, faint traces of at least two other depsides sometimes occur with the sphaerophorin. One of these is 4-*O*-demethylsphaerophorin and the other may be isosphaeric acid (see below), although this could not be confirmed with certainty. Figure 1 represents a copy of part of three plates, run in solvent systems A, B, and C (Culberson & Ammann 1979), comparing perlatolic acid (position 1) and sphaerophorin (pos. 2), and the hydrolysis products of perlatolic acid (pos. 3), stenosporic acid (pos. 4), and sphaerophorin (pos. 5). Notice that the Rf values of intact perlatolic acid and sphaerophorin are very similar and that only solven system B gives even a clue that the two are distinct compounds. The two are very easily mis-

Fig. 1. A copy of a small portion of three plates, which have been run in the three standard solvent systems, A, B, and C. Each plate bears perlatolic acid (position 1) and sphaerophorin (2), and the hydrolysis products of perlatolic acid (3), stenosporic acid (4), and sphaerophorin (5). In each case, the lower dashed line represents the position of the standard norstictic acid control and the upper dashed line represents the standard atranorin control. Note that on each plate and for each hydrolysis product, the lower spot represents the B-ring phenolic unit and the upper spot represents the A-ring phenolic unit (the two units from sphaerophorin coincide on plate A, therefore showing only one spot).


A
B
C

taken for one another in all three solvent systems, but a mistake is particularly likely if only one or two solvent systems are used. The hydrolysis products on the other hand are easily distinguished from one another if all three standard solvent systems are used.

The alkaline solvent system (ethyl acetate, methanol, ammonium hydroxide; 75:20:5) recommended by Archer (1993) for separation of orcinol para-depsides in *Pertusaria* was also tested to see if it would distinguish sphaerophorin from perlatolic acid. In that solvent system, sphaerophorin ran about 2-3 Rf points above perlatolic acid, which would normally be enough to distinguish the two. More experimentation needs to be done with this solvent system to gauge its overall utility in separating the many similar lichen depsides.

Sphaerophorin has still not been commonly reported from lichens, although it is now known to be the major constituent in at least one other species of *Cladonia*. *Cladonia imbricaria*, a member of the *C. chlorophaea* group originally thought to produce imbricaric acid (Culberson & Kristinsson 1969; Kristinsson 1974), actually produces sphaerophorin (Culberson et al. 1985). In that species it was reported to be accompanied by 4-*O*-demethylsphaerophorin and possibly isosphaeric acid, which are also suspected as trace components in *C. petrophila*. Sphaerophorin is now also known as a major constituent in one chemotype of *Dimelaena oreina* (Culberson et al. 1984). Sphaerophorin may well prove to be more common than previously suspected, appearing rare only because of the difficulty of distinguishing it from other depsides.

The distribution map published by Harris appears to be a generally accurate representation of the distribution of *C. petrophila*, which is apparently restricted to eastern North America. Although Harris described the distribution as an Appalachian-Ozark pattern with a disjunct in Wisconsin, the Ohio specimens cited below, which come from the Allegheny Plateau, may indicate that the Wisconsin element is not so disjunct after all.

Specimens Examined: Kentucky. Barren Co.: Mammoth Cave National Park, near Frozen Niagara Entrance, *Dey 10115*, *10301*, *10332*, *14659* (Herb. Dey). Edmonson Co.: Houchins Ferry Road, *Dey 11030* (Herb. Dey), near Temple Hill Cemetery, *Dey 10985* (Herb. Dey), near visitor center and Cave Island Nature Trail, *Dey 11901* (Herb. Dey). Massachusetts. Franklin Co.: ca. 8 miles NW of Amherst, near Whately, *Esslinger 4040* (Herb. Esslinger). Ohio. Tuscarawas Co.: Rush Township, 8 miles S of Urichsville, *Anderegg 270*, *329*, *332*, *333*, *337*, *338*, *343*, *344*, *345*, *346*, *1092* (Herb. Esslinger & Herb. Anderegg). Tennessee. Carter Co.: Dennis Cove Campground, *Harris 10730* (MOR, isotype).

Acknowledgements - I thank Doyle Anderegg and Jon Dey for the loan of specimens from their private herbaria, and Richard Harris of New York for arranging the loan of the isotype specimen which is to be placed permanently at MOR. Thanks are due to Jon Dey also for a critical review of this paper.

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MELIOLACEAE OF SOUTHERN INDIA - XVI

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Abstract

This paper presents an account of twenty-four taxa of Meliolaceae collected from the southern Indian states of Kerala, Karnataka and Tamil Nadu. Of these, Amazonia mayteni, Meliola semecarpi-anacardii, M. swieteniicola and M. vepridis are new species; Appendiculella calophylli (Stev.) Toro var. apetali is a new variety, while Irenopsis tjibodense Hansf., Meliola africana Hansf., M. macropoda Sydow and M. serjaniae Stev. var. major Hansf. are reported for the first time from India. The remaining species are either new records for the respective states from which they have been collected or form new host records.

Key words: Amazonia, Appendiculella, Irenopsis, Meliola, Southern India

1. **Amazonia mayteni** sp. nov. (Fig. 1)

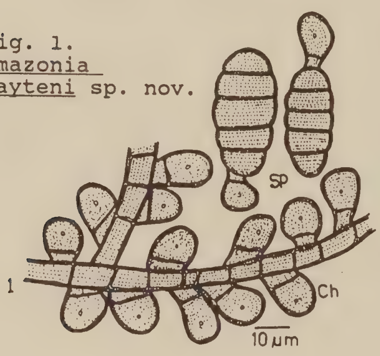
Coloniae plures epiphyllae, densae, crustosae vel velutinae, usque ad 2 mm diam. Hyphae rectae vel subrectae, alternate ad angulum acutum ramosae, dense reticulatae, compactae et fere opaquae, cellulis 12-15.5 X 6-9.5 µm. Hyphopodia capitata alternata subantrorsa, 15-18.5 µm longa; cellula basalis cylindracea vel cuneata, 3-5 µm longa; cellula apicalis globosa, integra, 12-14 X 12-15.5 µm. Phialides non visa. Perithecia dispersa, applanata-globosa, usque ad 190 µm diam.; ascosporae obovoideae, 4-septatae, constrictae, 37-43.5 X 15-22 µm.

Colonies predominantly epiphyllous, dense, crustose to velvety, up to 2 mm in diameter. Hyphae straight to substraight, branching alternate at acute angles, very closely reticulate, compact and almost opaque, cells 12-15.5 X 6-9.5 µm. Capitate hyphopodia alternate, subantrorse, 15-18.5 µm long; stalk cells cylindrical to cuneate, 3-5 µm long; head cells globose, entire, 12-14 X 12-15.5 µm. Phialides not seen. Perithecia scattered, flattened-globose, up to 190 µm in diameter; ascospores obovoidal, 4-septate, constricted, 37-43.5 X 15-22 µm.

Holotype: On leaves of Maytenus rothiana (Walp.) Ramam. (Celastraceae), Gersoppa. Uttara Kannada, Karnataka, Oct. 10, 1992, P.A. Raghu HCIO 40853.

Amazonia stevensii Hansf. is the only species of this genus reported on members of the Celastraceae . The new species differs from it in having entire head cells of the capitate hyphopodia, in contrast to irregularly sublobate ones found in A. stevensii (Hansford, 1961).

Fig. 1.
Amazonia
mayteni sp. nov.



Key to abbreviations
for all figures:

Ch=capitate hyphopodia
Mh=phialides
(mucronate hyphopodia)
Ms=mycelial setae
Pa=perithecial appendages
Sp=ascospores

2. **Appendiculella calophylli** (Stev.) Toro var. **apetali** var. nov. (Fig. 2)

Differt a var. calophylli peritheciis, appendicibus peritheciales, et ascosporis brevioribus.

Colonies hypophyllous, subdense, crustose, up to 3 mm in diameter, rarely confluent. Hyphae substraight to flexuous, branching alternate, opposite to irregular at acute to wide angles, loosely to closely reticulate, cells 30-46.5 X 6-9.5 µm. Capitate hyphopodia alternate, less than 1% opposite, straight to curved, antrorse to recurved, 30-43.5 µm long; stalk cells cylindrical to cuneate, 6-31 µm long; head cells ovoid to globose, entire, angular, sublobate to sinuate, 12-25 X 9-25 µm. Phialides mixed with capitate hyphopodia, opposite to alternate, ampulliform, 18-31 X 9-12.5 µm. Perithecia scattered, up to 125 µm in diameter; perithecial appendages numerous, subcylindrical to mammiform, obtuse to hamate at the tip, up to 25 µm long; ascospores obovoidal, 4-septate, slightly constricted, 43-46.5 X 15-18.5 µm.

Holotype: On leaves of Calophyllum apetalum Willd. (Clusiaceae), Gersoppa, Uttara Kannada, Karnataka, Oct. 24, 1992. P.A. Raghu HCIO 40854.

This specimen bears a few projection-like appendages and other mammiform-like cells on the perithecia, suggestive of the genera Appendiculella Hoehnel and Asteridiella McAlpine. The morphology of the hyphopodia is similar to that of Appendiculella calophylli (Stev.) Toro, however. The new variety differs from the var. calophylli in having smaller perithecia, perithecial appendages and ascospores.

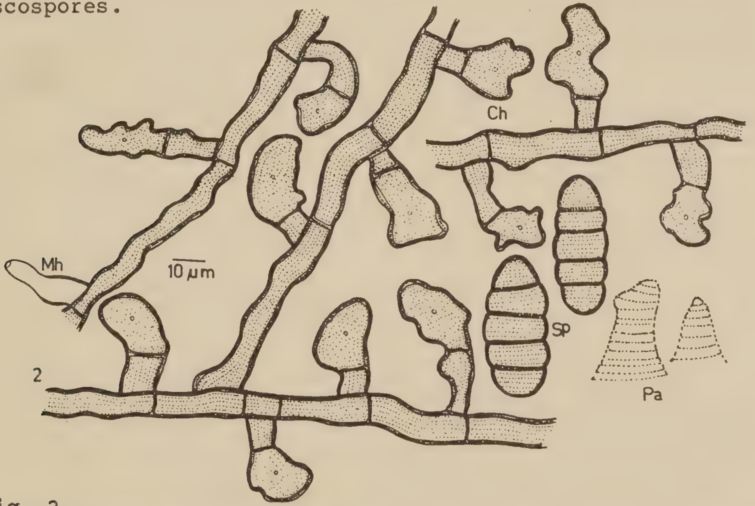


Fig. 2.
Appendiculella calophylli (Stev.) Toro var. apetali var. nov.

3. **Asteridiella clerodendricola** Hosagoudar in Hosagoudar & Goos, Mycotaxon 36: 273, 1989.

On leaves of Clerodendrum viscosum Vent. (Verbenaceae), Seithur hills, Kamarajar Dist., Tamil Nadu, Nov. 12. 1992, V.B. Hosagoudar HCIO 40855.

4. **Asteridiella formosensis** (Yamam.) Hansf., Sydowia 10: 48, 1957.

On leaves of Callicarpa tomentosa (L.) Murray (Verbenaceae), Gersoppa, Uttara Kannada, Karnataka, Oct. 25, 1992, P.A. Raghu HCIO 40856.

This species was recorded earlier from Kerala State (Hosagoudar & Goos, 1989) and is reported here for the first time from Karnataka.

5. **Asteridiella vivekananthanii** Hosagoudar, Sydowia 40: 114, 1987.

On leaves of Clerodendrum viscosum Vent. (Verbenaceae), Seithur hills, Kamarajar Dist., Tamil Nadu, Nov. 12, 1992, V.B. Hosagoudar HCIO 40861.

6. **Irenopsis tjibodense** Hansf., Reinwardtia 3: 106, 1954.

Colonies epiphyllous, thin, up to 6 mm in diameter. Hyphae substraight to rarely crooked, branching opposite to irregular at acute angles, loosely reticulate, cells 24-31 X 5-6.5 µm. Capitate hyphopodia alternate, antrorse, straight to rarely curved, 18-25 µm long; stalk cells cylindrical to cuneate, 6-12.5 µm long; head cells globose to ovoid, entire to angular, 12-15.5 X 12-14 µm. Phialides mixed with capitate hyphopodia, alternate to opposite, ampulliform, 12-18.5 X 6-8 µm. Perithecia scattered, seated on loosely reticulate exhyphopodiate mycelia, up to 120 µm in diameter; perithecial setae very few, straight to slightly flexuous, dark, tip obtuse, up to 120 µm long; ascospores obovoidal, 4-septate, slightly constricted, 31-34.5 X 12-15.5 µm.

On leaves of Pterospermum diversifolium Blume (Sterculiaceae), Gersoppa, Uttara Kannada, Karnataka, Oct. 22, 1992, P.A. Raghu HCIO 40862.

This species was recorded from Java and the Philippine Islands and is reported here for the first time from India on a hitherto unrecorded host species.

7. **Meliola africana** Hansf., Sydowia 10: 62, 1957.

Colonies amphigenous, dense, velvety, up to 2 mm in diameter, confluent. Hyphae substraight to flexuous, branching opposite to irregular at acute to wide angles, loosely reticulate, cells 18-37.5 X 8-9.5 µm. Capitate hyphopodia alternate, closely antrorse to spreading, 21-31 µm long; stalk cells cylindrical to cuneate, 6-12.5 µm long; head cells ovoid, oblong, entire, 12-18.5 X 12-15.5 µm. Phialides borne on a separate mycelial branch, alternate to opposite, ampulliform or conoid, 15-18.5 X 9-11 µm. Mycelial setae densely scattered, simple, straight, acute to obtuse at tip, up to 520 µm long. Perithecia scattered, verrucose, up to 186 um in diameter; ascospores cylindrical to slightly ellipsoidal, 4-septate, constricted, 34-40.5 X 12-18.5 µm.

On leaves of Canthium angustifolium Roxb. (Rubiaceae), Gersoppa, Uttara Kannada, Karnataka, Oct. 24, 1992, P.A. Raghu HCIO 40863.

Both Meliola africana Hansf. and M. longiseta Hoehnel come under the Beeli formula 3111.4223. The former species differs from the latter in having entire head cells of the capitate hyphopodia and in having phialides borne on a separate mycelial branch.

This species was recorded from Uganda, Sierra Leone and Java and is reported here for the first time from India on a hitherto unrecorded host genus.

8. **Meliola artocarpi** Yates. Philippine J. Sci. 12: 362, 1917.

On leaves of Artocarpus heterophyllus Lam. (Moraceae), Vittal, Dakshina Kannada, Karnataka, Nov. 20, 1992, P.A. Raghu HCIO 40864.

9. **Meliola clerodendricola** Henn., Hedwigia 37: 288, 1895.

On leaves of Clerodrendrum viscosum Vent. (Verbenaceae), Gersoppa, Uttara Kannada, Karnataka, Dec. 3, 1992, J. Bhandary HCIO 40865.

10. **Meliola densa** Cooke, Grevillea 12: 85, 1884.

On leaves of Eugenia sp. (Myrtaceae), Hosmatta, Dakshina Kannada, Karnataka, Aug. 31, 1992, H.S.P. Shenoy HCIO 40866.

11. **Meliola entadicola** Deighton, Sydowia 11: 104, 1958.

Colonies amphigenous, mostly epiphyllous, thin, confluent. Hyphae straight to substraight, branching alternate to opposite at acute to wide angles, loosely to closely reticulate, cells 24-34 X 4-6.5 µm. Capitate hyphopodia alternate and opposite, straight to curved, antrorse to recurved, 12-15.5 µm long; stalk cells cylindrical to cuneate, 4-6.5 µm long; head cells ovoid, globose to oblong, entire to rarely angular, 7-9.5 X 6-8 µm. Phialides mixed with capitate hyphopodia, alternate to opposite, ampulliform, 15-22 X 6-9.5 µm. Mycelial setae fairly numerous, scattered, straight to rarely and slightly flexuous at the upper portion, acute, obtuse to dentate at the tip, up to 430 µm long. Perithecia scattered, up to 125 µm in diameter; ascospores oblong to cylindrical, 4-septate, slightly constricted at the septa, 34-37.5 X 12-15.5 µm.

On leaves of Entada rheedii Sprengel (E. persaetha DC.) (Mimosaceae), Gersoppa, Uttara Kannada, Karnataka, Oct. 24, 1992, P.A. Raghu HCIO 40867.

This species was recorded from Sierra Leone and is reported here for the first time from India on a hitherto unrecorded host species.

12. **Meliola erythrinae** Sydow, Ann. Mycol. 15: 185, 1917.

On leaves of Erythrina stricta Roxb. (Fabaceae), Vettiyar, Mavelikkara, Kerala, Nov. 15, 1992, C.M. Pillai HCIO 40868.

This species was recorded from Maharashtra (Uppal et al., 1935; Srinivasulu, 1974) and Tamil Nadu (Hosagoudar & Goos, 1991) and is reported here for the first time from Kerala.

13. **Meliola indica** Sydow var. **careyae** Stev., Ann. Mycol. 26: 223, 1928.

On leaves of Careya arborea Roxb. (Lecythidaceae), Hosmatta, Subramanya, Dakshina Kannada, Karnataka, Aug. 31, 1992, H.S.P. Shenoy HCIO 40869.

14. **Meliola jayachandranii** Hosagoudar, Sydowia 40: 117, 1987.

On leaves of Isonandra lanceolata Wight var. anfractuosa C.B. Clarke (Sapotaceae), Seithur hills, Kamarajar Dist., Tamil Nadu, Nov., 1992, V.B. Hosagoudar HCIO 40870.

15. **Meliola longiseta** Hoehnel, Sitzb. K. Akad. Wiss. Wien, Math. -naturw. Kl. 116: 100, 1907.

Colonies amphigenous, hyphophyllous colonies mostly on the veins, dense, velvety, up to 5 mm in diameter. Hyphae substraight to flexuous, branching alternate to irregular at acute angles, loosely reticulate, cells 24-46.5 X 6-8 µm. Capitate hyphopodia alternate, antrorse, straight to curved, 24-37.5 µm long; stalk cells cylindrical to cuneate, 9-15.5 µm long; head cells ovoid to globose, entire to angular, crenately lobate to lobate, 15-22 X 15-18.5 µm. Phialides mixed with capitate hyphopodia, alternate to opposite, ampulliform, 24-28 X 9-12.5 µm. Mycelial setae scattered, straight, simple, acute to obtuse at the tip, up to 750 µm long, setae around perithecia small and pale in colour. Perithecia scattered to loosely grouped, verrucose, up to 150 µm; ascospores obovoidal, straight to slightly curved, 4-septate, slightly constricted, 40-46.5 X 12-15.5 µm.

On leaves of Canthium dicoccum (Gaertn.) Teijsm. & Binn. var. umbellata (Wight) Sant. & Merch. (Rubiaceae), Gersoppa, Uttara Kannada, Karnataka, Nov. 23, 1992, P.A. Raghu HCIO 40871.

Based on the morphology of the capitate hyphopodia and the position of the phialides, this collection has been assigned to M. longiseta Hoehnel, but it varies slightly in the ascospore morphology.

This species was recorded on Psychotria sp. from Samoa and is reported here for the first time from India on a hitherto unrecorded host genus.

16. **Meliola macropoda** Sydow, Ann. Mycol. 24: 290, 1926.

Colonies amphigenous, dense, crustose to velvety, up to 5 mm in diameter. Hyphae straight to substraight, branching mostly opposite at acute to wide angles, loosely to closely reticulate, cells 24-46 X 6-8 µm. Capitate hyphopodia alternate, straight to slightly curved, antrorse to spreading, 21-28 µm long; head cells ovate to elongate-ovate, entire to slightly angular, often bluntly pointed towards the apex, 12-18.5 X 9-12.5 µm. Phialides mixed with capitate hyphopodia, opposite to alternate, ampulliform, 18-28 X 9-12.5 µm. Mycelial setae scattered straight, simple, most obtuse at the tip, up to 580 µm long. Perithecia scattered, up to 205 µm in diameter; ascospores obovoidal, 4-septate, constricted, 40-52 X 15-22 µm.

On leaves of Vepris bilocularis (Wight & Arn.) Engl. (Rutaceae), Gersoppa, Uttara Kannada, Karntaka, Oct. 21, 1992, P.A. Raghu HCIO 40872 (p.p.).

This species stands distinct from the rest of the Meliola species reported on Rutaceae in having distantly arranged and spreading capitate hyphopodia and elongate-ovate head cells of the capitate hyphopodia. This species was associated with Meliola vepridis sp. nov.

This species was recorded on Zanthoxylum spp. from Costa Rica and Panama and is reported here for the first time from India on a hitherto unrecorded host genus.

17. **Meliola mitragynae** Sydow, Philippine J. Sci. 8: 478, 1913.

On leaves of Mitragyna parvifolia (Roxb.) Korth. (Rubiaceae), Gersoppa, Uttara Kannada, Karnataka, Oct. 24, 1992, P.A. Raghu HCIO 40873.

This species is reported here for the first time from southern India.

18. **Meliola nothopegiae** Hansf., Sydowia 10: 80, 1957.

On leaves of Nothopegia racemosa (Dalz.) Ramam. (Anacardiaceae), Gersoppa, Uttara Kannada, Karnataka, Oct. 21, 1992, P.A. Raghu HCIO 40874.

This species is reported here for the first time on this host species.

19. **Meliola rickiana** Hansf. var. **zanthoxyli** Hosagoudar in Hosagoudar & Goos, Mycotaxon 37: 245, 1990.

On leaves of Zanthoxylum ovalifolium Wight (Rutaceae), Seithur hills, Kamarajar dist., Tamil Nadu, Nov. 7, 1992, V.B. Hosagoudar HCIO 40875.

This taxon is reported here for the first time from Tamil Nadu.

20. **Meliola serjaniae** Stev. var. **major** Hansf., Sydowia 9: 49, 1955.

Colonies epiphyllous, dense, velvety, up to 5 mm in diameter. Hyphae straight to substraight, branching mostly opposite at wide angles, loosely reticulate, cells 24-32.5 X 6-9.5 µm. Capitate hyphopodia alternate, about 1% opposite, antrorse to subantrorse, straight to curved, 18-25 µm long; stalk cells cylindrical to cuneate, 6-9.5 µm long; head cells ovate, clavate, entire to angular, 12-15.5 X 9-15.5 µm. Phialides mixed with capitate hyphopodia, alternate to opposite, ampulliform, 15-22 X 6.9.5 µm. Mycelial setae evenly scattered over the colonies, straight, simple, acute to obtuse at the tip, up to 510 µm long. Perithecia scattered, verrucose, up to 175 µm in diameter; ascospores obovoidal to cylindrical, 4-septate, slightly constricted, 40-45 X 12-15 µm.

On leaves of Sapindus laurifolia Vahl (Sapindaceae), Kasaragod, Kerala, Nov. 25, 1992, J. Bhandary HCIO 40876.

This species was recorded on Serjania species from Brazil and Costa Rica and is reported here for the first time from India on a hitherto unrecorded host genus.

21. **Meliola semecarpi-anacardii** sp. nov. (Fig. 3)

Coloniae epiphyllae, densae, crustosae, usque ad 3 mm diam. Hyphae rectae, opposite acuteque vel laxe ramosae, dense reticulatae et tegetes myceliales densae formantes, cellulis 15-18.5 X 6-9.5 µm. Hyphopodia capitata alternata, antrorsa vel subantrorsa, 18-28 µm longa; cellula basalis cylindracea vel cuneata, 6-9.5 µm longa; cellula apicalis ovata, globosa, integra vel angularis, 12.5-18.5 X 12-15.5 µm. Phialides illis capitatis commixtae, alternatae vel oppositae, ampullaceae, 18-22 X 9-12.5 µm. Setae myceliales numerosae, simplices, rectae, acutae ad apicem, usque ad 500 µm longae. Perithecia dispersa vel laxe aggregata, verrucosa, usque ad 250 µm diam.; ascosporae obovoideae, 4-septatae, profunde constrictae, 49-56 X 21-25 µm.

Colonies epiphyllous, dense, crustose, up to 3 mm in diameter. Hyphae straight, branching opposite at acute to wide angles, closely reticulate, forming dense mycelial mat, cells 15-18.5 X 6-9.5 µm. Capitate hyphopodia alternate, antrorse to subantrorse, 18-28 µm long; stalk cells cylindrical to cuneate, 6-9.5 µm long; head cells ovate, globose, entire to angular, 12.5-18.5 X 12-15.5 µm. Phialides mixed with capitate hyphopodia, alternate to opposite, ampulliform, 18-22 X 9-12.5 µm. Mycelial setae numerous, simple, straight, acute at the tip, up to 500 µm long. Perithecia scattered to loosely grouped, verrucose, up to 250 µm in diameter; ascospores obovoidal, 4-septate, deeply constricted at the septa, 49-56 X 21-25 µm.

Holotype: On leaves of *Semecarpus anacardium* L.f. (Anacardiaceae), Vittal, Dakshina Kannada, Karnataka, Nov. 24, 1992, P.A. Raghu HCIO 40877.

The new species has Beeli formula 3111.5332 and is close to *Meliola rhois* Henn. var. *africana* Hansf. It differs from it in having strictly epiphyllous colonies, in having entire head cells of the capitate hyphopodia, and in having phialides mixed with capitate hyphopodia. It also differs from *M. semecarpicola* Hansf. in not showing a pathogenic effect on the host. Another species, *M. travancoricae* Hosag., recorded on the same host genus from the Western Ghats, differs from the new species in having smaller capitate hyphopodia, perithecia and ascospores.

22. **Meliola swieteniicola** sp. nov. (Fig. 4)

Coloniae amphigenae, plerumque epiphyllae, densae, velutinae, usque ad 3 mm diam., saepe confluentes. Hyphae rectae vel subrectae, alternate vel opposite et acute vel laxe ramosae, laxe reticulatae, cellulis 15-22 X 6-8 µm. Hyphopodia capitata alternata (raro aliquot opposita in colonis juvenilibus), plerumque antrorsa, 15-22 µm longa; cellula basalis cylindracea vel cuneata, 6-9.5 µm longa; cellula apicalis ovata vel globosa, integra, 9-14 X 9-12.5 µm. Phialides illis capitatis commixtae, plerumque oppositae, ampullaceae, 15-18.5 X 6-9.5 µm. Setae myceliales dispersae, rectae, usque ad 286 um longae, plerumque dentatae et raro furcatae usque ad 10 µm ad apicem. Perithecia dispersa, verrucosa, usque ad 170 µm diam.; ascosporae obovoideae, 4-septatae, leniter constrictae, 40-43.5 X 15-18.5 um.

Colonies amphigenous, mostly epiphyllous, dense, velvety, up to 3 mm in diameter, widely confluent. Hyphae straight to substraight, branching alternate to opposite at acute to wide angles, loosely reticulate, cells 15-22 X 6-8 µm. Capitate hyphopodia alternate (rarely few opposite in young colonies), mostly antrorse, 15-22 µm long; stalk cells cylindrical to cuneate, 6-9.5 µm long; head cells ovate to globose, entire, 9-14 X 9-12.5 µm. Phialides mixed with capitate hyphopodia, mostly opposite, ampulliforn, 15-18.5 X 6-9.5 µm. Mycelial setae scattered, straight, up to 286 µm long, mostly dentate and rarely furcate, up to 10 µm at the tip. Perithecia scattered, verrucose, up to 170 µm; ascospores obovoidal, 4-septate, slightly constricted at the septa, 40-43.5 X 15-18.5 µm.

Holotype: On leaves of *Swietenia mahagoni* (L.) Jacq. (Meliaceae), Kaiga, Uttara Kannada, Karnataka, Nov. 21, 1992, K.M. Kaveriappa HCIO 40878.

The new species is similar to Meliola swieteniae Cif. recorded on the same host from San Domingo (Cifferi, 1933) but differs from it in having phialides mixed with capitate hyphopodia and mycelial setae lightly furcate at the tip.

23. **Meliola tamarindi** Sydow, Ann. Mycol. 10: 79, 1912.

On leaves of Tamarindus indica L. (Caesalpiniaceae), Gersoppa, Uttar Kannada, Karnataka, Nov. 13, 1992, C.M. Pillai HCIO 40879.

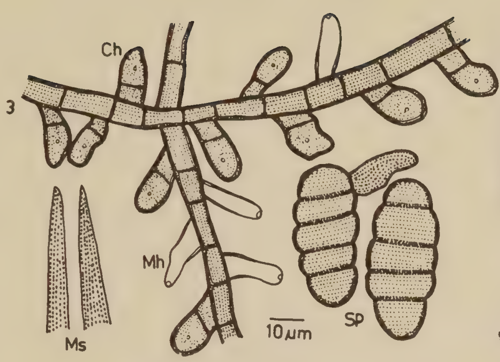
24. **Meliola vepridis** sp. nov. (Fig. 5).

Coloniae amphigenae, densae, crustosae vel velutinae, usque ad 4 mm diam., raro confluentes. Hyphae rectae vel subrectae, plerumque opposite laxe ramosae, dense reticulatae et teges mycelialis solida formantes, cellulis 21-31 X 8-9.5 µm. Hyphopodia capitata alternata, recta vel curvula, antrorsa vel recurva, 24-31 µm longa; cellula basalis cylindracea vel cuneata, 6-12.5 µm longa; cellula apicalis ovata, globosa, cylindracea, integra, angularia vel sublobata, raro truncata ad apicem, 15-18.5 X 14-17 µm. Phialides illis capitatis commixtae, alternatae vel oppositae, ampullaceae, 18-22 X 11-12.5 µm. Setae myceliales numerosae, simplices, rectae, aliquot uncinatae, acutae ad apicem, usque ad 930 µm longae. Perithecia dispersa, usque ad 186 µm diam.; ascosporae obovoideae vel cylindraceae, 4-septatae, constrictae, 46-56 X 20-22 µm.

Colonies amphigenous, dense, crustose to velvety, up to 4 mm in diameter, rarely confluent. Hyphae straight to substraight, branching mostly opposite at wide angles, closely reticulate, forming a solid mycelial mat, cells 21-31 X 8-9.5 µm. Capitate hyphopodia alternate, straight to curved, antrorse to recurved, 24-31 µm long; stalk cells cylindrical to cuneate, 6-12.5 µm long; head cells ovate, globose, cylindrical, entire, angular to sublobate, often truncate at the apex, 15-18.5 X 14-17 µm. Phialides mixed with capitate hyphopodia, alternate to opposite, ampulliform, 18-22 X 11-12.5 µm. Mycelial setae fairly numerous, simple, straight, very few uncinate, acute at the apex, up to 930 µm long. Perithecia scattered, up to 186 µm in diameter; ascospores obovoidal to cylindrical, 4-septate, constricted, 46-56 X 20-22 µm.

Holotype: On leaves of Vepris bilocularis (Wight & Arn.) Engl. (Rutaceae), Gersoppa, Uttara Kannada, Karnataka, Oct. 21, 1992, P.A. Raghu HCIO 40880.

This species has Beeli formula 3111.5323 and can be compared with Meliola kisubiensis Hansf. and M. macropoda Sydow. It differs from the former species and its four varieties in having longer capitate hyphopodia with entire, angular to sublobate head cells. It differs from the latter species in having robust and carbonaceous dark mycelia and hyphopodia.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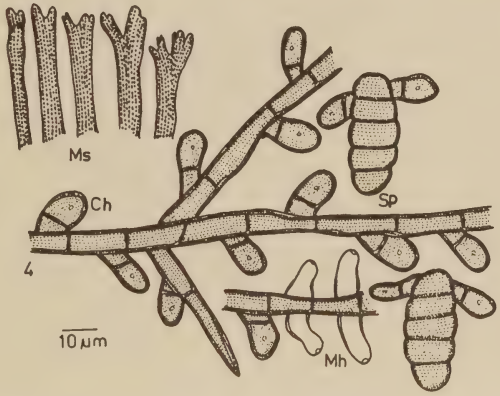
Ch
Mh
Ms
Sp
10 µm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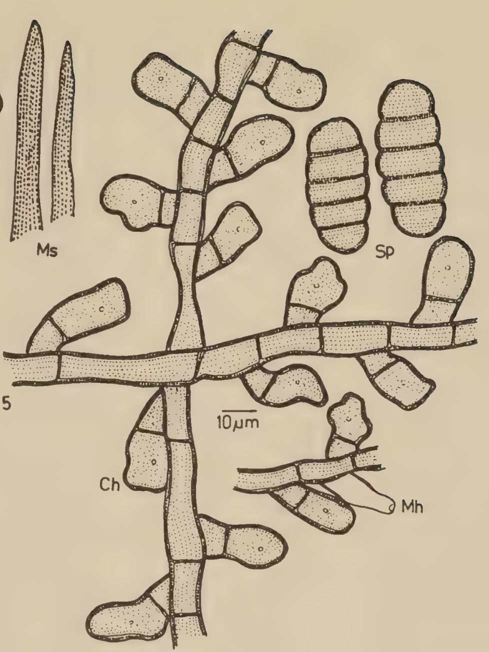
5
Ms
Sp
Ch
Mh
10 µm

Fig. 3. Meiola semecarpi-anacardii sp. nov.
Fig. 4. Meliola swieteniicola sp. nov.
Fig. 5. Meliola vepridis sp. nov.

This species was associated with Meliola macropoda Hansf.

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Meliola symphorematicola sp. nov. from India

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Key words: Meliola symphorematicola, new species.

During the exploration of foliicolous fungi in the Western Ghats of southern India, Symphorema involucratum Roxb. (Symphoremataceae) was found infected with black mildew fungus. Critical microscopic observation revealed that the fungus is an undescribed species of the genus Meliola Fr.

Meliola symphorematicola sp. nov. (Fig. 1)

Coloniae amphigenae, plerumque hypophyllae, densae, usque ad 5 mm diam. Hyphae valde ad hospitem appressae, rectae, flexuosae vel anfractae, laxe inangulo recto oppositae, racemosae, laxe vel dense reticulatae, cellulis 15-22 X 3-6.5 µm. Hyphopodia capitata plerumque alternata, antrorsa vel patentia, recta vel curvata, 12-15.5 um longa, cellula basali cylindracea vel cuneata, 3-6.5 um longa, cellula apicali globosa vel ovata, recta vel curvata, integra, 9-10 X 9-12.5 µm. Phialides pauce, illis capitatis commixtae, alternatae vel oppositae, ampullaceae, 13-15.5 X 6-9.5 µm. Setae myceliales numerosae, simplices, plerumque rectae, paucae uncinatae vel geniculatae, acutae ad apicem, usque ad 375 µm longae. Perithecia dispersa vel laxe aggregata, usque ad 130 µm; ascosporae obovoideae, 4-septatae, leniter constrictae, 34-40.5 X 12-18.5 µm.

Colonies amphigenous, mostly hyphophyllous, dense, up to 5 mm in diameter. Hyphae strongly appressed to the host, straight, flexuous to crooked, branching opposite at wide angles, loosely to closely reticulate, cells 15-22 X 3-6.5 µm. Capitate hyphopodia alternate and about 5% opposite, antrorse to spreading, straight to curved, 12-15.5 µm long; stalk cells cylindrical to cuneate, 3-6.5 µm long; head cells globose to ovate, straight to curved, entire, 9-10 X 9-12.5 µm. Phialides mixed with capitate hyphopodia, alternate to opposite, ampulliform, 13-15.5 X 6-9.5 µm. Mycelial setae numerous, simple, predominantly straight, few uncinate to geniculate, acute at the tip, up to 375 µm long. Perithecia scattered to loosely grouped, up to 130 µm; ascospores obovoidal, 4-septate, slightly constricted, 34-40.5 X 12-18.5 µm.

Holotype: On leaves of _Symphorema involucratum_ Roxb. (Symphoremataceae), Dhoni forest, Palghat Dist., Kerala State, India, March 1, 1993, V.B. Hosagoudar HCIO 46881.

Stevens & Roldan (1935) described _Meliola symphoremae_ for a fungus collected on _Symphorema luzonicum_ in the Philippines. The name was not validly published because it lacked a Latin description (ICBN, Art. 36). Petrak (1958) was either unaware of _M. symphoremae_ Stevens & Roldan or simply considered it different from _M. symphonematis_ Petrak, collected on the same host and same island but from a different province. Since the fungus is named after the host, which Petrak also misspelled as _Symphonema_, the epithet _symphonematis_ is an orthographic variant to be corrected (ICBN, Arts, 73, 75). Thus _M. symphorematis_ Petrak is the appropriate basionym for the fungus described on _Symphorema_. Hansford (1963) used the correct form when he cited the new variety _M. symphorematis_ Petrak var. _major_ Hansf. The new species differs from the type of _M. symphorematis_ in having smaller and alternate to opposite capitate hyphopodia and larger ascospores. It differs from _M. symphorematis_ var. _major_ in having uncinate to geniculate mycelial setae.

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We are thankful to Mr. K. Ravikumar, Botanical Survey of India, Southern Circle, Coimbatore for identification of the host. One of us (VBH) is grateful to Scientists' Pool Scheme of CSIR, New Delhi for the financial assistance. We are most grateful to Dr. F.A. Uecker for his review of the manuscript and for his comments regarding nomenclature.

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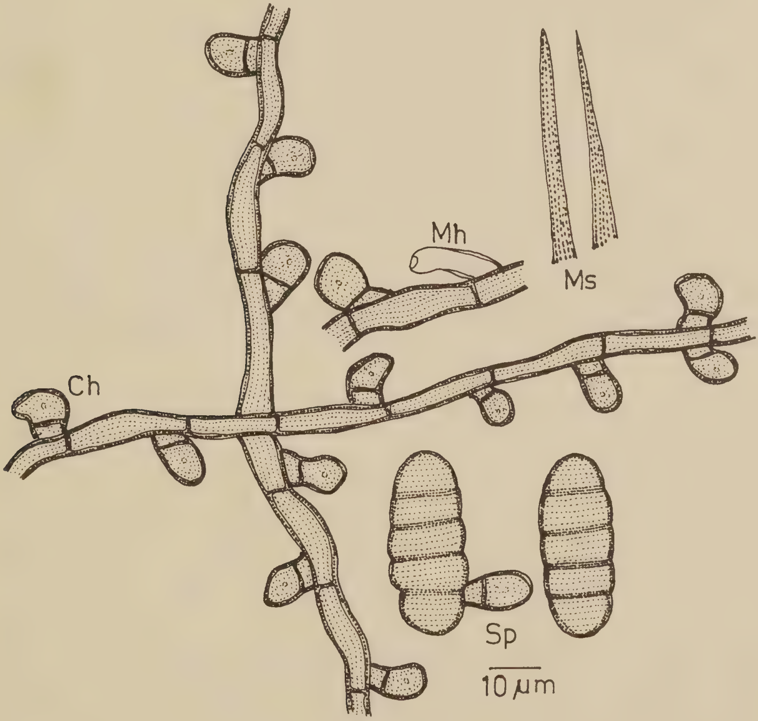

Fig. 1. Meliola symphorematicola sp. nov. (Ch = capitate hyphopodia, Mh = phialide; Ms = mycelial setae; Sp = ascospores)

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GLOMUS ANTARCTICUM SP.NOV., A VESICULAR-ARBUSCULAR MYCORRHIZAL FUNGUS FROM ANTARCTICA

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SUMMARY

The examination of soil samples collected on the rhizosphereof *Deschampsia antarctica* Dev. from Danco Coast, Antarctic Peninsula for vesicular arbuscular mycorrhizal (VAM) fungi revealed an undescribed species of *Glomus* which forms sporocarps and abundant soil-borne as well as intradical spores in pot cultures characterized by an evanescent outer wall, a laminated middle wall and a membranous inner wall.

Vesicular arbuscular are by far the most important and most widely distributed (geographically as well as within the plant kingdom) type of mycorrhiza.

They have been reported from all continents except Antarctica (Tinker, 1975). But during the "Campaña Antártica Argentina de verano 1989" undertaken by one of us (M.N. Cabello) the examination of rhizospheric soil of *Deschampsia antarctica* revealed that there are mycorrhiza in this Continent at least in Danco Coast, Base Primavera. The same locality is indicated in a map by Gamundí and Spinedi (1987).

Colobanthus quitensis Kunth (Caryophyllaceae) and *Deschampsia antarctica* Dev. (Gramineae) are the only two native phanerogams known from within the Antarctic botanical zone, as defined by Greene (1964).

The soil under *Deschampsia* was characterized as Cryosaprist (muck) genetically dependent on the Gramineae where it takes root (Leonardi et al., 1987). Its characteristics are: organic matter: 79,35%; mineral fraction: 2,80%; Total C: 46,02%; N: 3,40%; P: 306ppm; pH: 5,3.

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Spores were extracted from rhizospheric soil samples by wet-sieving and decanting (Gerdemann and Nicolson, 1963). Roots were cleared and stained (Phillips and Hayman, 1970).

This study revealed that rhizospheric soil and roots of *Deschampsia* are positively colonized by VAM, whereas *Collobanthus* has not mycorrhiza.

Spore wall terminology follows that of Walker (1983) and descriptions are based upon the appearence of spores mounted in a polyvinyl/alcohol/glycerol/lactic acid solution (PVLG) (Koske and Tessier, 1983). Collections have been deposited in the Herbarium of the Spegazzini Institute (LPS).

SPECIES DESCRIPTION

GLOMUS ANTARCTICUM Cabello sp. nov. Fig.1-6.

***Sporocarpia** sine peridio, globosa vel subglobosa, 1000 x 564 um diam., chlamydosporae in sporocarpiis per mycelium glomerulatae. **Chlamydosporae** fulvae vel fuscae, globosae, subglobosae, ovoideae vel irregulares, 50 x 75 um diam. **Sporae tunica** 3-12um crassa, stratis tribus: exteriore 2 um crassa, hyalino, ephemera; medio 4-8 um crasso, lutea vel brunnea ex laminosa, strato exteriore separabili, interiore 1,5-2 um crasso. Sporae ad hyphae subtendentes affixae, tunica exteriore breven parten hyphae proximam includente, et interiore per spatium 20 um in hypha extensa et eam incrassante. Sporarum contentus primo ab hypha a septo tenui separatus, maturarum a lamina interiore incrassata.*

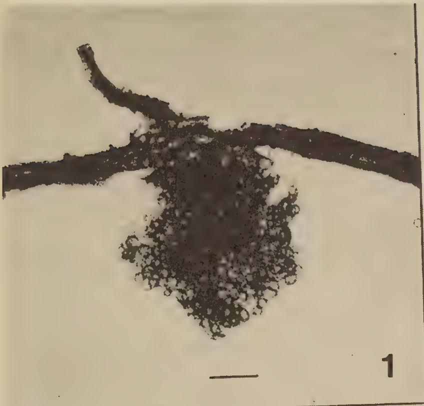
***HOLOTYPUS:** Antarctica, Peninsula Antarctica, Terra de Danco, Base Primavera, Leg. M.N. Cabello, I-1989, LPS 45265*

Sporocarps without peridium, globose or subglobose 1000 x 564 um diam.; sporocarps formed by interwoven hyaline hyphae, hyphae 3-5,5 um in diam. with 0,1-0,5 um thick walls; the surface of the sporocarps is knobby due to the appearence of spores.

Chlamydospores yellow to brown, globose to subglobose, occasionally ovoid or irregular, 50-70 um diam.

Spore wall structure 3-12 um consisting of three walls; the outer wall 2 um thick, ephemeral, hyaline; the middle layer 4-8 um thick, light brown, laminated; inner wall hyaline, 1,5-2 um thick.

Figure 1-6 *Glomus antarcticum sp. nov.*
1. Sporocarp attached to a piece of root.
2 & 3. Cluster of chlamydospores.
4. Mature chlamydospores; ow: outer wall, mw: middle wall, iw: inner wal.
5. Mature broken chlamydospores.
6. Sporulation in the root cortex of *Medicago sativa* in pot culture.
Bars represent 300 um in 1; 100 um in 2 & 6; 50 um in 3, 4 & 5.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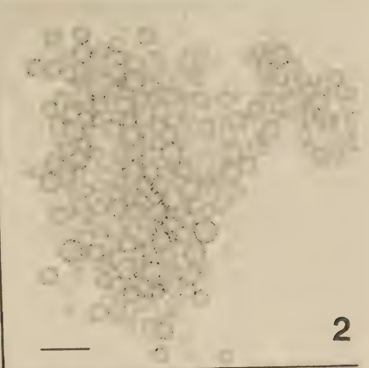
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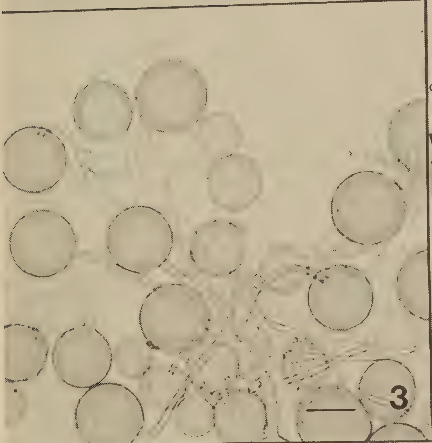
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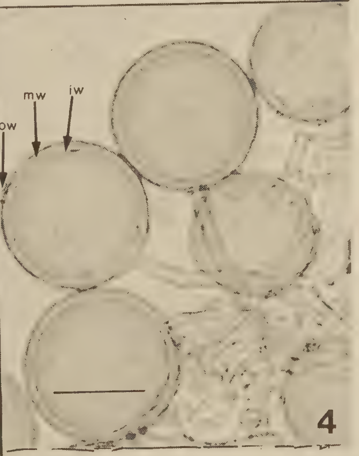

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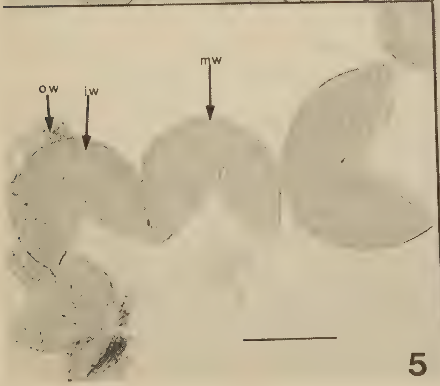

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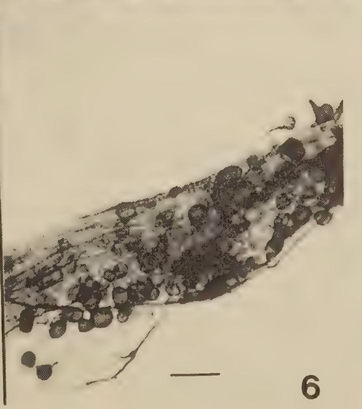
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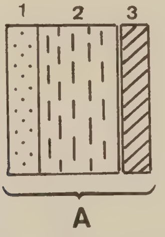
Spore with a hyphal attachment. Outer wall extending down the attached hypha thickened by the extension of the inner spore wall for up to 20 um.

Spore contents separated from the attached hypha by a thin septum; at maturity, the opening occluded by inner wall thickening.

Collection examined: Holotype, Antarctic Peninsula, Danco Coast, Cierva Cove, Base Primavera, leg. M.N. Cabello, I-1989, LPS 45265.
Paratype, originating from the rhizosphere of *Medicago sativa* L. LPS culture N° 81.

Murograph of *Glomus antarcticum*



Arabic numerals indicate each wall in order from outer to inner wall. Wall 1 is evanescent, wall 2 is laminated, wall 3 is membranous; the letter A indicates a wall grouping.

Distribution and habitat: *Glomus antarcticum* has been found in rhizospheric soil of *Deschampsia antarctica* at Danco Coast, Base Primavera, Antarctic Peninsula.

Mycorrhizal associations: forming vesicular-arbuscular mycorrhiza with alfalfa (*Medicago sativa* L) and sorghum (*Sorghum vulgare* Pers.) in pot cultures whose spore or root material is used as inoculum. Associated in the field with roots of *Deschampsia antarctica*.

DISCUSSION

Our description of *Glomus antarcticum* sp. nov. shows that it is closely related in size and shape to *G. fuegianum* (Spegazzini) Trappe & Gerdemann and *G. fasciculatum* (Taxter sensu Gerdemann) Gerdemann & Trappe. However, this new species has some characteristics that distinguish it from them. The sporocarps of *G. antarcticum* differ from *G. fuegianum* in the lack of peridium and in the chlamydospores that never arise from a vesicle supported by a broad sporophore. On the other hand, *G. antarcticum* spores revealed negative reaction to Melzer′s reagent and they have the outer unit wall evanescent while *G. fasciculatum* spores have an inner wall that turns red in

Melzer's reagent and the outer wall is not evanescent (Walker and Koske, 1987).

An other significant character that is used in identification of species of *Glomus* is the presence of a septum that occludes the lumen of the spore. In *G. antarcticum* this septum is constituted by the thickening of the inner wall of the subtending hypha at maturity; in *G. fuegianum* the amorphous material of the septum appears to be derived from modified cytoplasm (Yao et al., 1992) and in *G. fasciculatum* the spores are never occluded by a septum.

This study revealed the presence of a new species of *Glomus* which was isolated from rhizospheric soil of the only grass which grows in Antarctica: *Deschampsia antarctica*. This recovering in the Antarctic area answers the question made by Christie and Nicolson (1983) about if mycorrhizas were absent from the Antarctic. These authors have reported that mycorrhizas were not present in several places of Antarctic Peninsula included Spring Point. On the other hand, Stubblefield et al. (1987) found a fossil endogonaceous fungus that remebered them to *Sclerocystis*, in a silified matrix from the Triassic of Antarctica.

In field conditions a low number of spores and some colonized *Deschampsia* roots were found. By means of the pot culturing method active VAM fungal propagules were found in rhizospheric soil of *Deschampsia*. In this way *Glomus antarcticum* was isolated at the Spegazzini Institute.

ACKNOWLEDGEMENTS

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GLOMUS ANTARCTICUM: THE LIPIDS AND FATTY ACID COMPOSITION

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SUMMARY

The lipid and fatty acid composition were used as a biochemical character to distinguish *Glomus antarcticum* from other species of *Glomus*. Five species of *Glomus* namely: *Glomus antarcticum* Cabello; *Glomus clarum* Nicolson and Schenck, *Glomus fasciculatum*, (Thaxter sensu Gerdemann) Gerdemann and Trappe, *Glomus mosseae* (Nicolson and Gerdemann) Gerdemann and Trappe, and *Glomus versiforme* (Karst) Berch, were analyzed in order to distinguish each other in their lipid classes and fatty acid composition. This study revealed that *G. antarcticum* is clearly separated from the other species of *Glomus* here analyzed.

INTRODUCTION

The vesicular-arbuscular mycorrhizal (VAM) fungi are characterized by the presence of a high lipid content in their spores. This fact makes these metabolites useful for taxonomic purposes.

Several authors such as Cooper and Lösel, (1978); Nagy et al, (1980); Nordby et al, (1981); Beilby, (1980); Beilby and Kidby, (1980) reported the ocurrence of high levels of neutral lipids in external mycelium and in roots infected with *Glomus mosseae*; the composition of sterols and fatty acids of ungerminated spores of *Acaulospora laevis* and the lipid contents of *Glomus caledonium* spores; but only Jabaji-Hare, (1988) discussed

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the results from lipid analysis of extramatrical and intramatrical structures of *Gigaspora* and *Glomus* in relation to the taxonomic status.

In this paper we analyzed the lipids and fatty acids of the chlamydospores of five *Glomus* species and the results are discussed from a taxonomic point of view.

MATERIALS AND METHODS

The species of vesicular-arbuscular mycorrhizal fungi used in these experiments namely: *Glomus antarcticum* LPS culture N°81, *Glomus clarum* LPS culture N°69, *Glomus fasciculatum* LPS culture N°50, *Glomus mosseae* LPS culture N°52, and *Glomus versiforme* LPS culture N°80, were those available at the Spegazzini Institute.

Isolation of spores

The *Glomus* species were maintained on *Medicago sativa* L. Plants were grown in 500 ml capacity open pots of 9:1 sand/soil steamed mixture. *Medicago sativa* seeds were sown in moistened sand and after 2 weeks the seedlings were transplanted to the pots and grown under evironmental conditions.

Sporocarps and chlamydospores were collected from the pot cultures by wet-sieving and decanting (Gerdemann and Nicolson, 1963). They were picked up by using a dissecting microscope (40 X) and were removed from soil detritus with the aid of thin forceps.

Extraction and analysis of lipids

Samples of ungerminated chlamydospores (1-2 mg wet cells) were finely disrupted in a small conic glass tube with isopropyl alcohol, to inactivate the lipases and phospholipases before extracting the lipids with chloroform/methanol (2:1 v/v) by the technique of Folch et al. (1957). The preparations were checked microscopically to ensure that cell walls had been fractured.

Total lipids were analyzed by thin-layer chromatography (TLC) on HPTLC Silicagel 60 plates (Merck, Darmstadt, Germany) using hexane/ether/acetic acid (80:20:2 v/v) for neutral lipid separation and chloroform/methanol/acetic acid/water (65:25:4:4 v/v) or chloroform/methanol/28% aqueous ammonia (65:35:5 v/v) for phospholipids. The spots were localized by exposing the plates to iodine vapor. Lipids were identified by comparison of their Rf values with corresponding standards run on the same plates or by spraying the plates with specific reagents.

The quantitative determination of the lipid classes was performed by TLC coupled to a flame ionization detector (FID) in a Iatroscan apparatus model TH 10 (Iatron Laboratories, Japan) after their separation on chromarods type S-III using triple development as previously described (Heras and Pollero, 1989). Neutral and polar lipid classes were quantified by comparison with known amounts of standards run under the same conditions and using monoacylglycerol as internal standard (Ackman, 1990). Total lipids were calculated by the summation of individual lipid weights. The signals from the FID were registered on a Hewlett-Packard model HP-3396 A integrator.

Extraction and analysis of fatty acids

Aliquots of the extracts of total lipids and triacylglycerols were saponified with 10% potassium hydroxide in ethanol at 80°C for 45 min. under nitrogen. The unsaponifiables were extracted with petroleum ether. The fatty acids were extracted with petroleum ether after acidification and esterified with 3N HCl in methanol. Fatty acid methyl esters were analyzed by gas-liquid chromatography (GLC) in a Hewlett Packard 5840 A apparatus equipped with a flame ionization detector. A column packed with 10% SP-2330 on Chromosorb WAW was used. Temperature was programmed for a linear increase of 3°C per min from 140 to 220°C (Pollero, 1986). The chromatographic peaks were identified by comparison of their retention times with those of standards chromatographed under the same conditions. The chain length of the fatty acids was determined by rechromatographing the samples after hydrogenation (Farquhar et al., 1959). The number of double bonds of the unsaturated fatty acids was confirmed by separation of methyl esters by TLC-$AgNO_3$, using the technique proposed by Dudley and Anderson (1975). Each fraction was eluted and analyzed again by GLC as described above.

RESULTS

The total lipid content of the five *Glomus* species analyzed is shown in the following Table:

Lipids	*Glomus antarcticum*		*Glomus clarum*		*Glomus fasciculatum*		*Glomus mosseae*		*Glomus versiforme*	
	% W/W wet	% W/W lipid	% W/W wet	% W/W lipid	% W/W wet	% W/W lipid	% W/W wet	% W/W lipid	% W/W wet	% W/W lipid
Total lipids	76.0 ± 3.8	100	80.7 ± 6.3	100	38.1 ± 4.8	100	69.5 ± 2.4	100	47.2 ± 5.4	100
Neutral lipids	58.2 ± 2.5	76.6	63.2 ± 1.3	78.3	31.8 ± 3.7	83.5	55.2 ± 2.1	79.4	42.6 ± 3.2	90.3
Polar lipids	17.8 ± 1.3	23.4	17.5 ± 1.0	21.7	6.3 ± 0.5	16.5	14.3 ± 1.3	20.6	4.6 ±1.0	9.7

Neutral lipids were the most significant fraction in all species, mainly in *G. fasciculatum* and *G. versiforme* which represented 84% and 90% of total extracted lipids, respectively. Comparing the percentages of neutral and polar lipids from *G. antarcticum* with those from the other species is noted that this species presents similar values to that found in *G. clarum* and *G. mosseae*.

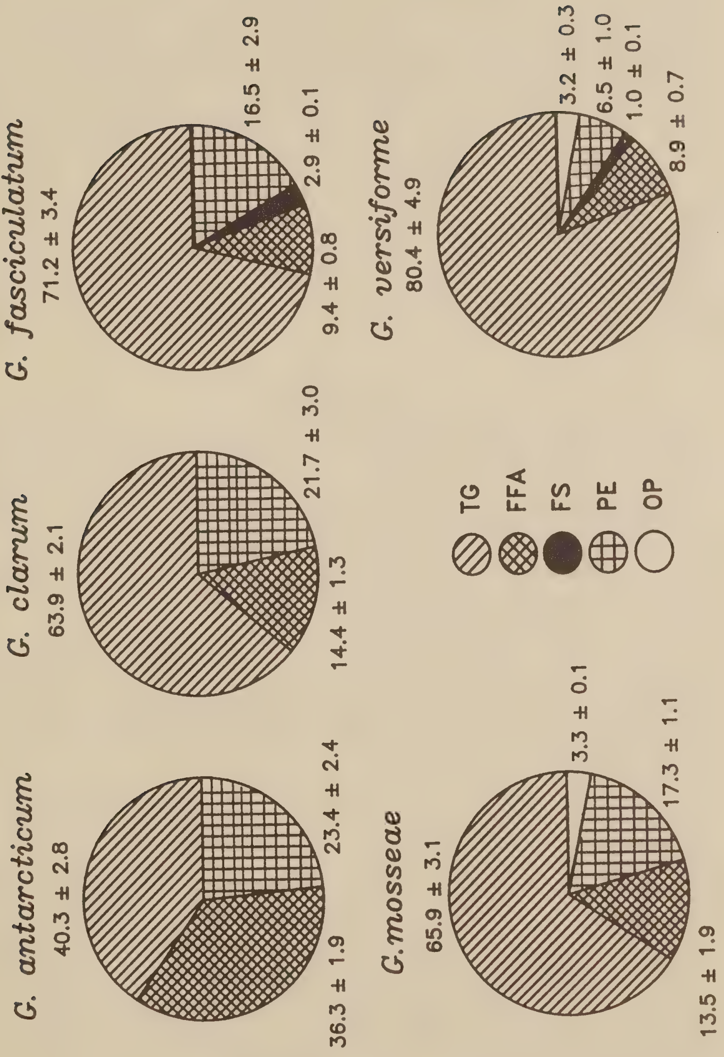
The principal characteristic of neutral lipids in all the species was the high content of triacylglycerols. Despite this fact, *G. antarcticum* chlamydospores differ in the minor amounts of triacylglycerols (Fig. 1). On the other hand, the high levels of free fatty acids distinguish *G. antarcticum* chlamydospores from the other *Glomus* species studied. Free sterols were detected only in *G. fasciculatum* and *G. versiforme*.

The polar lipid fraction from *G. antarcticum*, *G. clarum* and *G. fasciculatum* was found to be constituted by phosphatidylethanolamine as the only phospholipid. In addition to this common phospholipid, a compound running very close to lisophosphatidylcholine and showing positive reactions to phospholipid and free amine groups was also present in *G. mosseae* and *G. versiforme*.

Percent compositions of the main fatty acids from total lipids of the five VAM species, determined by GLC, are illustrated in the following Table:

Fatty acids	*Glomus antarcticum*	*Glomus clarum*	*Glomus fasciculatum*	*Glomus mosseae*	*Glomus versiforme*
14:0	4.2 ± 0.1	1.8 ± 0.1	0.5 ± 0.2	1.9 ± 0.1	1.7 ± 0.2
16:0	23.7 ± 0.3	25.1 ± 0.2	5.6 ± 0.2	22.2 ± 0.1	11.9 ± 0.2
16:1	26.1 ± 0.4	27.2 ± 0.1	41.3 ± 0.6	15.8 ± 0.4	53.2 ± 0.8
18:0	8.9 ± 0.1	7.0 ± 0.2	1.4 ± 0.1	8.3 ± 0.1	3.6 ± 0.1
18:1 ●9	16.0 ± 0.2	14.8 ± 0.1	12.1 ± 0.2	12.7 ± 0.4	12.0 ± 0.3
18:2 ●6	3.2 ± 0.0	5.7 ± 0.1	1.3 ± 0.1	3.0 ± 0.1	1.8 ± 0.2
18:3 ●6	0.5 ± 0.1	2.4 ± 0.0	0.5 ± 0.1	0.2 ± 0.0	1.8 ± 0.4
18:3 ●3	0.6 ± 0.2	0.5 ± 0.1	0.4 ± 0.0	0.7 ± 0.1	0.1 ± 0.1
20:3 ●6	0.9 ± 0.1	2.1 ± 0.1	1.7 ± 0.2	0.8 ± 0.1	1.1 ± 0.3
20:4 ●6	0.8 ± 0.1	3.5 ± 0.1	3.5 ± 0.1	0.9 ± 0.2	0.8 ± 0.1
20:5 ●3	1.1 ± 0.1	3.6 ± 0.3	3.7 ± 0.1	1.8 ± 0.2	1.1 ± 0.1
22:3 ●6	1.2 ± 0.2	0.2 ± 0.0	4.3 ± 0.1	0.1 ± 0.0	0.7 ± 0.2
22:3 ●3	0.6 ± 0.0	3.9 ± 0.2	2.1 ± 0.1	1.5 ± 0.5	0.9 ± 0.1
22:4 ●6	0.5 ± 0.1	1.2 ± 0.5	4.9 ± 0.2	0.5 ± 0.0	1.1 ± 0.1

Fig. 1 Quali-quantitative (percent) variations of the lipid classes of the *Glomus* species analyzed. TG: triacylglycerols, FFA: free fatty acids, FS: free sterols, PE: phosphatidylethanolamine, OP: other phospholipid. Results represent the average of four determinations ± extreme deviation of the mean.


G. antarcticum
40.3 ± 2.8
23.4 ± 2.4
36.3 ± 1.9
G. clarum
63.9 ± 2.1
21.7 ± 3.0
14.4 ± 1.3
G. fasciculatum
71.2 ± 3.4
16.5 ± 2.9
2.9 ± 0.1
9.4 ± 0.8
G.mosseae
65.9 ± 3.1
3.3 ± 0.1
17.3 ± 1.1
13.5 ± 1.9
G. versiforme
80.4 ± 4.9
3.2 ± 0.3
6.5 ± 1.0
1.0 ± 0.1
8.9 ± 0.7
TG
FFA
FS
PE
OP

Monoenoic acids of 16 and 18 carbons predominated over saturated acids, but their relative proportions varied upon the different species. Palmitoleic acid, (16:1) reached higher values in *G. fasciculatum* and in *G. versiforme* than in *G. antarcticum* while palmitic acid (16:0) and stearic acid (18:0) of both *Glomus* species *G. fasciculatum* and *G. versiforme*, are in lower percentages than in the new *Glomus* species. Nevertheless, the proportions of 16:0, 16:1, 18:0 and 18:1 in *G. antarcticum*, *G. clarum*, and *G. mosseae* are very similar.

Minor quantities of α and τ isomers of linolenic acid as well as other polyunsaturated fatty acids of ω6 and ω3 series are also present. *G. clarum* and *G. versiforme* show the gamma isomer (18:3 ω6) in higher percentages than those of the other species. In respect to ω6 and ω3 polyunsaturated fatty acids, the ω6 fatty acids in general predominated quali-quantitatively over those of the ω3 series.

DISCUSSION

Although *G. antarcticum* is distinguished from the other four VAM species studied by morphological characteristics the comparative analysis of the lipids components and the fatty acids compositions can be used as a chemotaxonomic character that contributes to delimit fungal species. In support of the separation of *G. antarcticum* from the remaining *Glomus* species is the fact that triacylglycerols are present in minor percentages and the free fatty acids are higher.

In addition to this fact, the detection of free sterols, the presence of high levels of 16:1, the low content of 16:0 and 18:0 and high relative amounts of polienoic fatty acids in *G. fasciculatum* are other characteristics that contribute to segregate *G. antarcticum* from this species which is the most similar morphologically.

A comparison of the lipid classes and fatty acid composition of *G. antarcticum* with other species of *Glomus* previously reported (Beilby and Kidby, 1980 and Jabaji-Hare, 1988) shows that in *G. antarcticum* chlamydospores the triacylglycerol proportions are comparatively lower than those found in the spores of *G. caledonium* Gerdemann y Trappe, *G. intraradices* Schenck and Smith, and *G. vesiculiferum* (Thaxter) Gerdemann y Trappe; while the polar lipids of *G. antarcticum* chlamydospores are surprisingly abundant when compared to the low levels found in *G. intraradices* and *G. vesiculiferum* where phospholipids represent less than 2% of the total lipids.

In respect to the fatty acid composition, the small differences of such spectra among *G. antarcticum*, *G. clarum*, and *G. mosseae* appear to be not correlatet with the morphological characteristics. Considering other *Glomus* species such as *G. intraradices* and *G.*

vesiculiferum (Jabaji-Hare, 1988) they contain enormous quantities of 16:1 and very low percentages of 16:0 and 18:0 in relation to the values found in *G. antarcticum* chlamydospores.

G. antarcticum chlamydospores are clearly different in their classes of lipids from the other *Glomus* species analyzed, while in their fatty acid composition it differs clearly to those closely related species, such as *G. fasciculatum* and *G. versiforme*.

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A RECORD OF STEREUM PLICATULUM FROM INDIA

by

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SUMMARY

Stereum plicatulum Lloyd was known only from the type material for the last sixty years until it was collected by the present author in 1981 from India. Lloyd described this species based on the material collected by Prof.A.Yasuda in 1921 from Japan.It is the only description published so far but it is a very short morphological description.In the present paper detail morphological and anatomical characters of *Stereum plicatulum* has been provided based on the Indian collection made by the author.

During a mycological excursion in October,1981, a non-poroid fungus of Aphyllophorales was collected by the author from a dead branch of an unknown angiosperm at Zero,Arunachal Pradesh,India.It was identified as *Stereum plicatulum* Lloyd. *Stereum plicatulum* was known only from the type material for the last sixty years until the present collection was made from India.It may be mentioned here that Stevenson and Cash (1936) cited the authority of *Stereum plicatulum* as '(Peck) Llyod'. But authority of this taxon should be cited simply as 'Llyod' (De 1990).
Stereum plicatulum was described by Lloyd (1922) based on the type material collected by Prof.A.Yasuda in october 1921 from Sendai,Japan.It was reported and illustrated by Lloyd (1922: 1157,fig.2286) as "*Stereum plicatulum* from Prof.A.Yasuda,Japan",characterized as "Named by Peck as a form of *Stereum spadiceum* and no doubt a form, but quite different in appearance from usual, being 'narrow, much crisped and folded' and with adpressed hairs, smooth to the eye. Although this was named *Stereum spadiceum* by Prof.Yasuda,until we sectioned it,we thought it was *Stereum spectabile*, which it closely resembles in general appearance. The color when moist is tawny (R) rather than 'buckthorn brown'". It is the only description published so far but it is a very short morphological

1

2

description. In the present paper detail morphological and anatomical characters of Stereum plicatulum Lloyd has been provided based on the Indian collection made by the author.

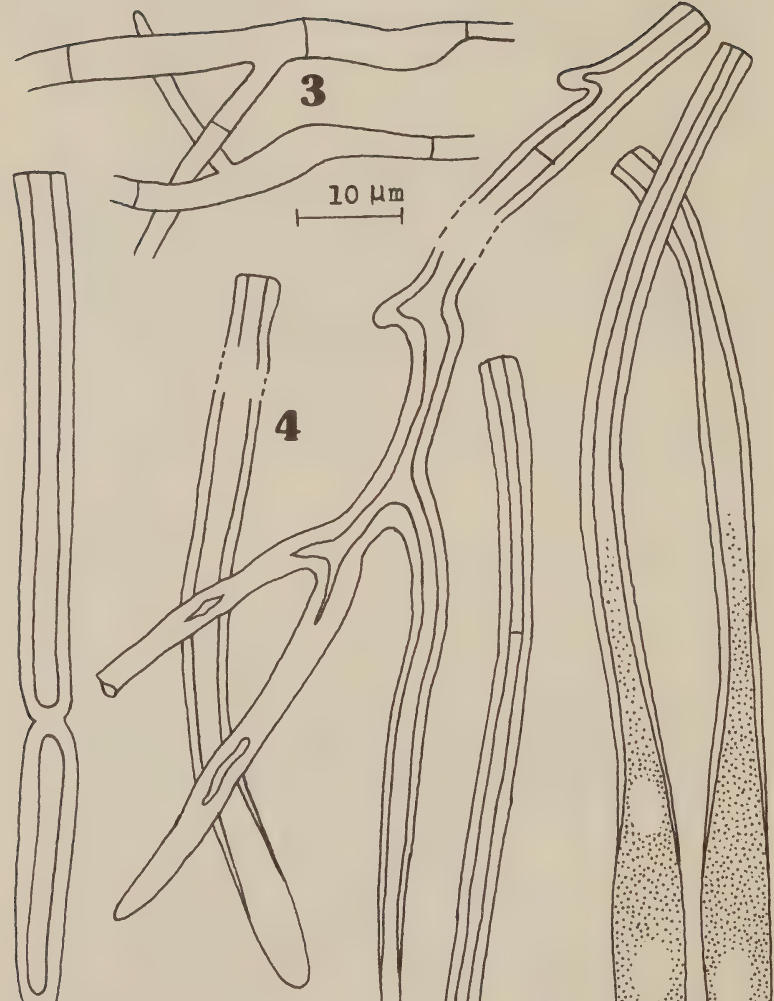
Stereum plicatulum Lloyd
Mycol.Writ.7 Mycological Notes No.67:1157.

Basidiocarp (Figs.1 & 2) effused-reflexed, tough when fresh, hard on drying, usually up to 680 µm thick; pileus narrowly reflexed to flabelliform, often lobed and wavy, at first finely adpressed tomentose to velutinate, smooth to the eye, soon becoming glabrous, tawny, generally zonate; margin thinning or acute, concolourous, involute, especially when dried;context hyaline to yellowish; hymenial surface smooth, crisped and folded radially, yellowish or pale orange.
Hyphal system dimitic. Generative hyphae (Fig.3) hyaline, thin-walled, simple-septate, branched, irregularly wide, 2.4-3.6 µm in diam. bearing narrower branches of 1.2-1.8 µm diam.; skeletal hyphae (Fig.4) hyaline, thick-walled to solid, often with secondary septa, usually unbranched,occasionally with 2-3 apical branches,apex variable,some thin-walled, others thick-walled and slightly constricted a little below the tip,2.4-4.8 µm in diam.; basidia (Fig.5) hyaline, thin-walled, clavate, 13.8-15.6 X 2.4-3.0 µm, bi- and tetrasterigmatic,sterigmata 2.4-3.6 µm long;basidiospores (Fig.6) hyaline,thin-walled,smooth,ellipsoid,4.8-6.0 X 1.8-2.4 µm, uniguttulate, apiculate,amyloid,acyanophilous;skeletocystidia (Fig.7) abundant, arising from the trama and forming a fairly dense layer next to the hymenium,smooth,thick-walled but apically thin-walled,hyaline to subhyaline and with granular to oily contents, 4.8-6.0 µm wide.

TYPE OF ROT: White rot.

SPECIMEN EXAMINED: BRCMH TA-6,Zero,Arunachal Pradesh,India,5754 ft. above sea level,on dead branch of an unknown angiosperm, 23.X.1981. Kept in the (BRCMH) Mycological Herbarium,Department of Botany,Burdwan Raj College, Burdwan,West Bengal,India. A portion of the specimen has been deposited in the Kew Herbarium, Richmond, Surrey, England.

Figs.1. & 2. Stereum plicatulum: 1. upper surface of basidiocarp; 2. hymenial surface of basidiocarp.


10 µm

REMARKS: The species is easily recognised by its effused-reflexed basidiocarp with tawny upper surface, yellow to pale orange, crisped and radially folded hymenial surface, dimitic hyphal system with simple-septate generative hyphae and skeletal hyphae, presence of skeletocystidia with granular to oily contents, small (13.8-15.6 X 2.4-3.0 µm), clavate basidia and small (4.8-6.0 X 1.8-2.4 µm), amyloid, acyanophilous basidiospores.

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Figs. 3-7. Microscopic structures from basidiocarp of Stereum plicatulum: 3. generative hyphae; 4. skeletal hyphae; 5. basidia; 6. basidiospores; 7. skeletocystidia.

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PREDACIOUS FUNGI FROM ECUADOR

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Abstract

Nine species of nematode-trapping fungi were isolated from soil samples from different sites in Ecuador. They all belong to the Hyphomycetes and capture nematodes by means of sticky hyphal outgrows or constricting rings. The highest site with a predacious fungus (*Monacrosporium parvicolle*) was at 4,200 m altitude. The possible preference of species for a hot and humid climate, as well as the taxonomy of certain species of *Monacrosporium* are discussed.

Introduction

The cosmopolitan distribution of predacious fungi has been shown in the past decades by the work of many authors. Different substrata or habitats have been studied (Gray, 1983). However, preferences of the species for certain substrata are not always evident. An investigation of factors influencing the presence of predatory fungi in soil revealed that pH and moisture are more significant than organic matter and nematode density (Gray, 1985).

In South and Central America a survey for predacious fungi was made in Argentina (Gamundí & Spinedi, 1982). Lappe and Ulloa (1983) reported nematode-destroying fungi from Mexico, Bucaro (1983) from El Salvador. It was therefore very likely that predacious fungi would be found in soils in Ecuador, too.

Ecuador comprises various geological formations, different climatic zones and, consequently, very different types of vegetation: The lowlands in the eastern part of the country (Oriente), the Andes rising up to 6,300 m, and the western tropical lowlands of the so-called Costa extending over a large area between the Andes and the Pacific coast. The map (Fig. 1) roughly shows the geographical situation and the climatic zones of Ecuador (Gómez, 1990). The sampling sites are marked with dots and numbers.

Material and Methods

Samples were taken in March 1993. About 5 g of soil were loosely wrapped in aluminum foil, stored for some days or weeks at room temperature and then brought to Germany. In the laboratory about 1 to 2 g of soil were sprinkled onto Petri dishes with water agar (sprinkled-plate method). The nematode species *Turbatrix aceti* Mull. was added to each plate in order to bait nematode-capturing fungi. One week later the plates were observed for the first time, and then at intervals of a few days up to the fifth week. Fungi, isolated by picking off conidia, were grown on cornmeal agar (Difco, half concentrated), the catching organs – if not produced spontaneously - were induced by the addition of nematodes to the pure culture.

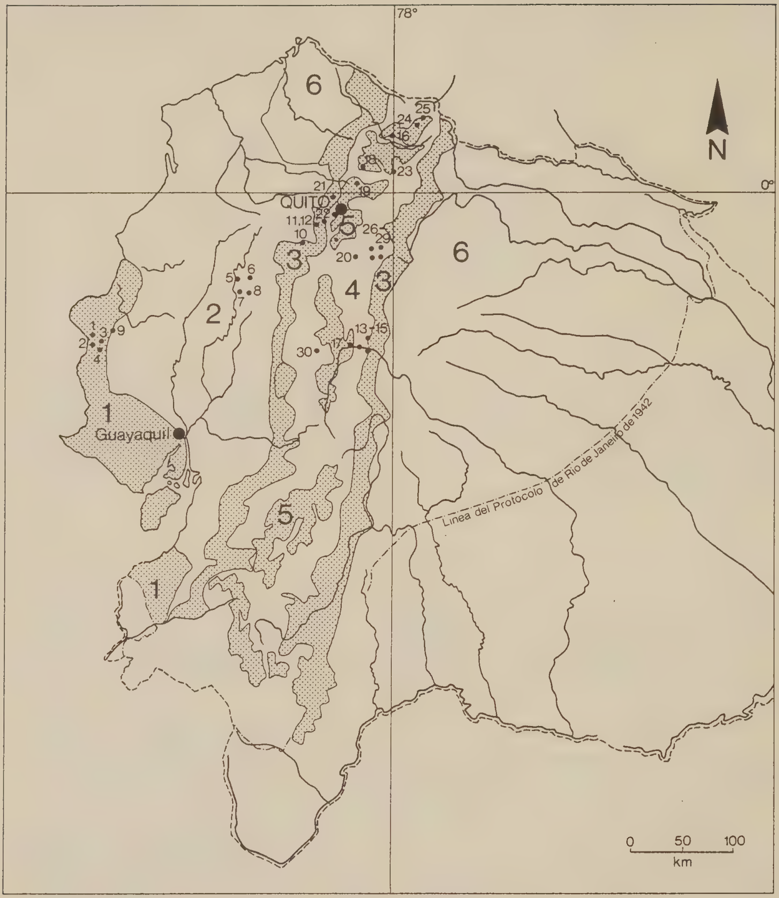
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Figure 1: climate zones of Ecuador (after Gómez, 1990); 1 = hot and (very) dry, 2 = hot and humid with a dry season, 3 = temperate and very humid – corresponding to the eastern and western slopes of the Andes, 4 = cold and humid – corresponding to the Cordilleras, 5 = temperate and humid – corresponding to the Andine plateaus, 6 = very hot and very humid. Places of sampling are marked by a dot (•) and a small number.

Table 1: Numbers of sampling sites (in accordance with Fig. 1), altitudes above sea level up to 4,500 m, habitats and species isolated.

sample no.	sampling site	height	habitat	species isolated
1	Machalilla	0 - 100 m	side of path	*M. eudermatum*
2			coastal sand	-
3			coastal sand	-
4			side of path	*M. eudermatum*
5	Quevedo	0 - 100 m	banana plantation	*A. musiformis*
6			maize field	-
7			rain forest	*A. musiformis*
8			maracuia plantation	-
9	Coastal mountains	about 600 m	ruderal	*A. brochopaga*
10	Rio Toachi	about 1,000 m	riverside	*M. phymatopagum*
11	Western Andes	about 1,500 m	rain forest	-
12			rain forest	-
13	Baños	about 1,500 m	lemon plantation	*A. musiformis* *A. superba*
14			pasture	*A. conoides* *A. musiformis*
15			side of path	-
16	Chota valley	about 1,800 m	dry meadow	-
17	Tungurahua	about 2,200 m	horsestring	*A. musiformis*
18	Cuicocha	about 2,500 m	side of road	-
19	Ecuator	about 2,500 m	ruderal	*M. psychrophilum*
20	La Cienega	2,500 m	ruderal	*A. oligospora* *M. psychrophilum*
21	Pichincha	3,000 m	path	-
22			path	-
23	Olmedo	about 3,100 m	meadow	*M. psychrophilum*
24	El Angel	about 3,200 m	páramo	-
25			side of road	-
26	Cotopaxi	3,500 m	pine forest	-
27		4,000 m	páramo	-
28		4,000 m	red soil	-
29		4,200 m	páramo	*M. parvicolle*
30	Chimborazo	4,500 m	páramo	-

Most of the isolates (A.R. 935 – A.R. 9317) are kept in permanent culture at the Institute of Systematic Botany, Berlin (BSB).

Results

Twentyfour isolates were obtained from 60 sprinkled plates (30 soil samples, Table 1). Endoparasitic fungi as well as predacious Zygomycetes were sometimes encountered, but no attempts were made to cultivate them. Nine species of nematode-trapping Hyphomycetes were identified, five of which belong to *Arthrobotrys* and four to *Monacrosporium*.

1. ***Arthrobotrys brochopaga*** (Drechsler) S. Schenck, Kendrick & Pramer
Ref.: Drechsler, 1937, p. 514-518.
Material examined:
Province Manabi, between Jipijapa and Puerto de Cayo in the Coastal Mountains, appr. 600 m alt., ruderal soil (sample no. 9, A.R. 9314).

2. ***A. conoides*** Drechsler
Ref.: Drechsler, 1937, p. 473-477.
Material examined:
Province Tungurahua, near Baños, mountainous rain forest, approx. 1,500 m alt., plantation soil (sample no. 14, A.R. 9316).

3. ***A. musiformis*** Drechsler
Ref.: Drechsler, 1937, p. 477-482.
Material examined:
a) Province Los Ríos, between Quevedo and Jauneche, tropical lowland, banana plantation soil (sample no. 5).
b) Province Los Ríos, Jauneche, tropical lowland, forest soil (sample no. 7, A.R. 935).
c) Province Tungurahua, east of Baños, appr. 1,500 m alt., plantation soil (sample no. 13).
d) Province Tungurahua, east of Baños, appr. 1,500 m alt., pasture soil (sample no. 14).
e) Province Tungurahua, volcano Tungurahua, appr. 2,200 m alt., horsestring soil (sample no. 17, A.R. 939).

4. ***A. oligospora*** Fresenius
Ref.: Drechsler, 1937, p. 464-472.
Material examined:
Province Cotopaxi, north of Latacunga, Hacienda "La Cienega", appr. 2,500 m, ruderal soil (sample no. 20, A.R. 936).

5. ***A. superba*** Corda
Ref.: Drechsler, 1937, p. 450-459.
Material examined:
Province Tungurahua, east of Baños, mountainous rain forest, approx. 1,500 m alt., plantation soil (sample no. 13, A.R. 9311).

6. ***Monacrosporium parvicolle*** (Drechsler) R.C. Cooke & Dickinson
This species is well-characterized by its type of trapping organ: unstalked sticky knobs which readily grow out to form loops. These loops are many-celled and also covered with the sticky substance to which nematodes adhere. Conidia, often divided into five cells, produce sticky knobs on one or on both ends – even in pure culture

(without nematodes; Fig. 2 B). In contrast to Drechsler's (1961) description of *M. parvicolle* the Ecuadorian strain produced branched conidiophores (Fig. 2 D).
Material examined:
Province Cotopaxi, National Park Cotopaxi, 4,200 m alt., páramo soil (sample no. 29, A.R. 9310).

7. ***M. phymatopagum*** (Drechsler) Subramanian
The species resembles *M. parvicolle* in the shape and septation of conidia and the conidiophore which bears a single conidium. However, the conidia of *M. phymatopagum* are slightly longer and nematodes are trapped by single, unstalked cells, which do not grow out. The species was described in detail by Drechsler (1954).
Material examined:
Province Pichincha, Rio Toachi, mountainous rainforest, appr. 1,000 m alt., plantation soil (sample no. 10, A.R. 9313).

8. ***M. psychrophilum*** (Drechsler) R.C. Cooke & Dickinson
It was isolated three times and each of the isolates was checked most carefully regarding the size and shape of conidia as well as the tip of the conidiophore. The species differs from *M. reticulatum* (Peach) R.C. Cooke & Dickinson by smaller conidia and a conidiophore bearing more than one conidium at the tip (Peach, 1950). From *M. megalosporum* (Drechsler) Subramanian it can be distinguished by less ventricose conidia, i. e. the penultimate cell is less inflated (Drechsler, 1954). Sometimes *M. psychrophilum* develops a geniculate conidiophore, which caused Rifai (1975) to combine the epithet with *Geniculifera*. One isolate from Ecuador showed strongly geniculate conidiophores on some spots on the Petri dish (Fig. 3 B). Furthermore, secondary conidia (microconidia) were produced on water agar with lupine stems. These conidia were equal in size to those given by Drechsler (1944), but the (rarely occurring) septum – in contrast to the original description - was not median (Fig. 3 D).
Material examined:
a) Province Pichincha, 45 km north of Quito, appr. 2,500 m alt., ruderal soil (sample no. 19, A.R. 938).
b) Province Cotopaxi, north of Latacunga, Hacienda "La Cienega", 2,500 m alt., ruderal soil (sample no. 20, A.R. 9312).
c) Province Imbabura, near Olmedo, appr. 3,100 m alt., pasture soil (sample no. 23, A.R. 937).

9. ***M. eudermatum*** (Drechsler) Subramanian
This species is one of the many network-forming species with a simple, sometimes at the tip sparingly branched conidiophore and turbinate conidia with a large subterminal or terminal cell. Drechsler (1950) described the conidia as commonly three-septate and measuring 37–55 x 21–35 μm. The isolate A.R. 9315 fits *M. eudermatum* in conidial length and width, shape and number of septa (Table 2).

The isolate A.R. 9317, however, was not as definite in its identity as A.R. 9315. Using Cooke's (1967) key for network-forming species of *Monacrosporium*, A.R. 9317 fits *M. globisporum* R.C. Cooke in size, but not concerning septation. Another species, *M. sphaeroides* (Castaner, 1968) has comparable conidial length and width, but a different shape and septation. Drechsler (1950) recorded a variation of *M. eudermatum* conidia in size and septation (his Fig. 10 G), and these somewhat aberrant conidia are similar to those of strain A.R. 9317.

These considerations illustrate the taxonomic difficulties within this group of Hyphomycetes. It was already expressed by Cooke and Pramer in 1968, when they described *M. rutgeriense* (as *M. rutgeriensis*) and stated " ... intermediate forms of *Monacrosporium* exist and link known species into complexes, the components of

which are difficult to separate." In this study a wide species concept was chosen, and therefore both isolates, A.R. 9315 and A.R. 9317 are included in *M. eudermatum.*
Material examined:

a) Province Manabi, National Park Machalilla, coast, soil from side of path (sample no. 1, A.R. 9317).
b) Province Manabi, National Park Machalilla, coast, dry soil from side of path (sample no. 4, A.R. 9315).

Table 2: Network-forming species of *Monacrosporium* from the literature compared with two Ecuadorian strains A.R. 9315 and A.R. 9317. For literature see text and Cooke & Dickinson (1965).

species	**conidial length x width in μm**	**number of septa**
M. cystosporum	35–50 x 15–22.5	0–3, mostly 3
M. globisporum	27.5–39 x 17.5–22.5	1 and 2
M. rutgeriense	30–40 x 19–28	1–3, mostly 2-3
M. thaumasium	27–49 x 15–23	1–4, mostly 3
M. sphaeroides	28–42 x 19–29	0–3, mostly 1–2
M. eudermatum	37–55 x 21–35	mostly 3–septate
A.R. 9315 (*M. eud.*)	36.5–42–47.5 x 19.5–26.5–27.5	1–3, mostly 3
A.R. 9317 (*M. eud.*)	27–34.5–38.5 x 16–20.5–22.5	1–3, mostly 2–3

Discussion

The results of this survey principally confirm the cosmopolitan distribution of nematode-trapping Hyphomycetes. All the species isolated from Ecuador had been isolated before on other continents.

The finding of *Monacrosporium parvicolle* at an altitude of 4,200 m (páramo, Cotopaxi) is especially worth noting. Never before has a nematophagous fungus been found in such an altitude.

Arthrobotrys musiformis was isolated frequently, and the sampling sites are noteworthy (Table 1). It occurred four times in regions with a hot and humid climate, below 2,000 m altitude, where the temperatures remain high, even at night. Only once *A. musiformis* was isolated from soil above 2,000 m (Tungurahua volcano), but where treeferns still grow in a subtropical climate.

A. musiformis has not frequently been isolated in Germany. Mostly, it was found in soils of green-houses, heated in winter (Rubner, unpublished). The species was reported from Britain (Duddington, 1951) and Ireland (Gray, 1987), from the Netherlands, France, Scotland (CBS List of Cultures, 1990), countries with a more or less oceanic climate (and partly influenced by the Gulf stream). This suggests that *A. musiformis* is adapted to high temperatures and a humid climate.

M. psychrophilum was isolated three times. In contrast to *A. musiformis*, this species only occurred in the temperate zones of Ecuador. These zones are characterized by temperate or low temperatures and relatively high humidity (around

1,000 mm annual precipitation). The epithet *psychrophilum* refers to the preference for low temperatures; Drechsler (1944) found that growth is better at 15° – 20°C than near 25°C; the fungus is then more active in capturing nematodes and develops more conidia.

In contrast, the three Ecuadorian isolates reached 11 – 12 mm and 22 – 24 mm diam. in 3 days at 15° and 25°C, respectively, with better sporulation at 25°C than at 15°C. In another test, however, *M. psychrophilum* CBS 548.63 grew well at 11°C (radius 17 mm per week), but not at all at 30°C. Compared to twenty other predacious species (network-formers, ring-formers and those with sticky hyphal outgrows) this was the highest growth rate of all observed at 11°C. (At 30°C seven out of the twenty strains grew.)

M. psychrophilum was reported from several temperate countries: Denmark (Sheperd, 1956), England (Duddington, 1951, 1954), Germany (Fritsch & Lysek, 1989) and the maritime Antarctica (Gray et al., 1982). The CBS (1990) preserves isolates of *M. psychrophilum* from the UK (R.C. Cooke), and two isolates from Germany (W. Gams). Moreover, the species was frequently isolated from agricultural and meadowy soils in Sweden (L. Persmark, pers. comm.).

The Ecuadorian sites of isolation, literature data and Drechsler's observations suggest that *M. psychrophilum* is better adapted to low temperatures than many other predacious species.

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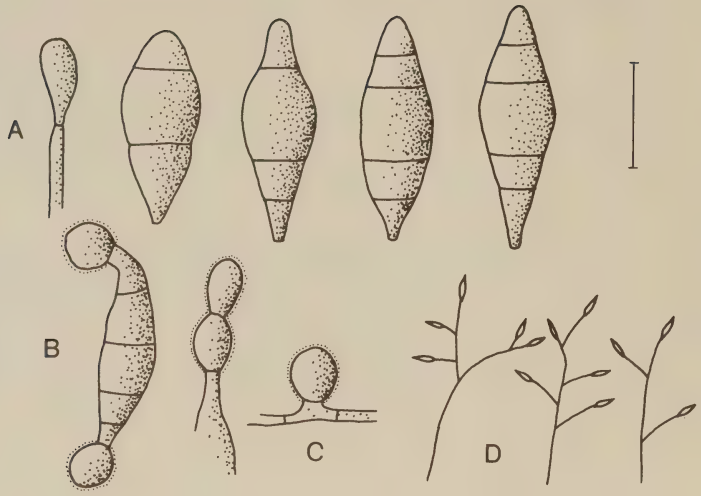

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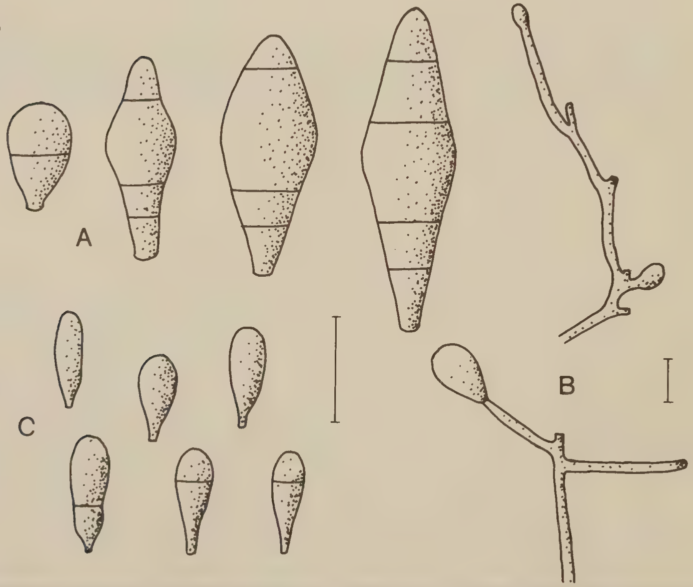

Figure 2: *Monacrosporium parvicolle*; A conidia, B mature conidia with sticky knobs, C sticky knob on hypha, D conidiophores as seen through the dissecting microscope. Figure 3: *M. psychrophilum*; A macroconidia, B geniculate conidiophore tips, C microconidia. Length of bars = 20 μm.

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TAXONOMICAL STUDIES ON USTILAGINALES. XI.*

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ABSTRACT

NEW SPECIES proposed: *Anthracoidea altiphila* K. Vánky & M. Piepenbring (type on *Carex jamesonii*, its var. *chordalis*, and on *C. pichinchensis*). – *Sporisorium langdonii* K. Vánky (type on *Themeda avenacea*). – *Sporisorium lingii* K. Vánky (type on *Themeda australis*). – *Sporisorium themedae-arguentis* K. Vánky (type on *Themeda arguens*). – *Sporisorium walkerii* K. Vánky (type on *Themeda australis*). – *Tilletia polypogonis* K. Vánky & N. D. Sharma (type on *Polypogon monspeliensis*). – *Urocystis camassiae* K. Vánky (type on *Camassia quamash*).

NEW COMBINATIONS proposed: *Sporisorium enteromorphum* (McAlpine) K. Vánky, based on *Ustilago enteromorpha* (type on *Anthistiria ciliata*). – *Sporisorium holstii* (P. Hennings) K. Vánky, based on *Sorosporium holstii* (type on *Themeda forskalii*). – *Sporisorium indehiscens* (L. Ling) K. Vánky, based on *Sphacelotheca indehiscens* (type on *Themeda gigantea*). – *Sporisorium punctatum* (L. Ling) K. Vánky, based on *Sphacelotheca anthistiriae* var. *punctata* (type on *Themeda triandra*). – *Sporisorium themedae* (Duke) K. Vánky, based on *Sphacelotheca themedae* (type on *Themeda triandra*). – *Sporisorium themedicolum* (L. Ling) K. Vánky, based on *Sphacelotheca themedicola* (type on *Themeda gigantea*). – *Thecaphora amaranthi* (Hirschhorn) K. Vánky, based on *Glomosporium amaranthi* (type on *Amaranthus* sp.). – *Ustilago microstegii* (S. Ahmad) K. Vánky, based on *Sphacelotheca microstegii* (type on *Microstegium nudum*).

The smut fungi of *Themeda* are revised, the recognised 16 species are described and a key to these species is given.

Ustilaginales on *Themeda* (Gramineae).

Trying to identify a smut fungus that I recently collected in Bali on *Themeda arguens*, I checked the descriptions and nearly all the types of the known Ustilaginales on *Themeda* (*Anthistiria*). The 16 published smut names on *Themeda* could be attributed to 12 species. The smut on *T. arguens* and three further ones on *T. avenacea* and *T. australis* turned out to be four distinct species and they are described as new.

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*Studies in Heterobasidiomycetes, part 101

To understand the localization of the sori it is necessary to know the structure of the inflorescence of *Themeda*. The unit of the inflorescence is a spatheolate raceme (Fig. 1). It consists of four, basal, sessile, awnless, staminate or neuter "involucral" spikelets and of "central" spikelets of 1(–4) sessile, fertile (female or hermaphrodite), usually awned spikelet(s), (each) with two pedicelled, staminate or neuter spikelets. Several short, spatheolate racemes form a flabellate cluster subtended by a larger spathe. Usually several spatheate clusters form the inflorescence.

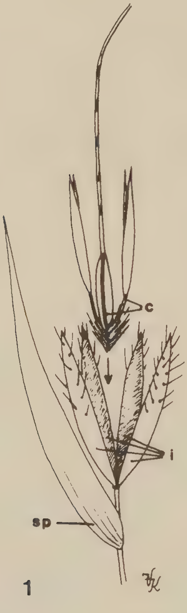

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Fig. 1. A raceme of a *Themeda* inflorescence composed of a spatheole (sp), four basal, sessile, awnless, staminate or neuter "involucral" spikelets (i), and (removed) central spikelets (c) composed of one sessile, fertile, awned spikelet and two pedicelled, staminate or neuter spikelets.

Sporisorium themedae-arguentis K. Vánky, **sp. nov.**

Typus in matrice *Themeda arguens* (L.) Hack., Indonesia, Bali, ca. 20 km S. Denpasar, Mt. Alas Kemayuna, 4 km S.W. pag. Nusa Dua, alt. ca. 80 m, 1.IV.1992, leg. C. Menge et K. Vánky. Holotypus in Herbario Ustil. Vánky (HUV 15375); isotypi in Vánky, Ustilaginales No. 855. Paratypi: Australia, 30 miles from Darwin to Humpty Doo, 20.III.1967, J. Heaton (BRIP 7883! ex BRIU 2451); Bali, ca. 60 km N.N.E. Denpasar, pr. lacum Batur, 2 km S.W. Hot Spring, alt. ca. 510 m, 4.IV.1992, leg. C. Menge et K. Vánky (HUV 15376); Bali, ca. 20 km E.N.E. oppid. Singaraja, alt. ca. 2 m, 5.IV.1992, leg. C. Menge et K. Vánky (HUV 15377); Bali, ca. 25 km E. oppid. Singaraja, alt. ca. 35 m, 5.IV.1992, leg. C. Menge et K. Vánky (HUV 15378).

Sori (Fig. 2) spiculas omnes unius racemi occupantes, cylindrici, initio cooperti membrana pallide brunnea cito evanescenti et sic ostendenti massam pulveream nigram glomerulorum sporarum et columellas nonnullas filiformes usque 50 mm longas e textura matricis formatas. Racemi omnes eiusdem inflorescentiae affecti. Membrana sori e stratis nonnullis arcte connectis cellularum fungi 4–7(–9) x 5,5–20 µm, concatenatarum, elongatarum, subangularium, tenuiter tunicatarum, pallide flavido-brunnearum. Glomeruli

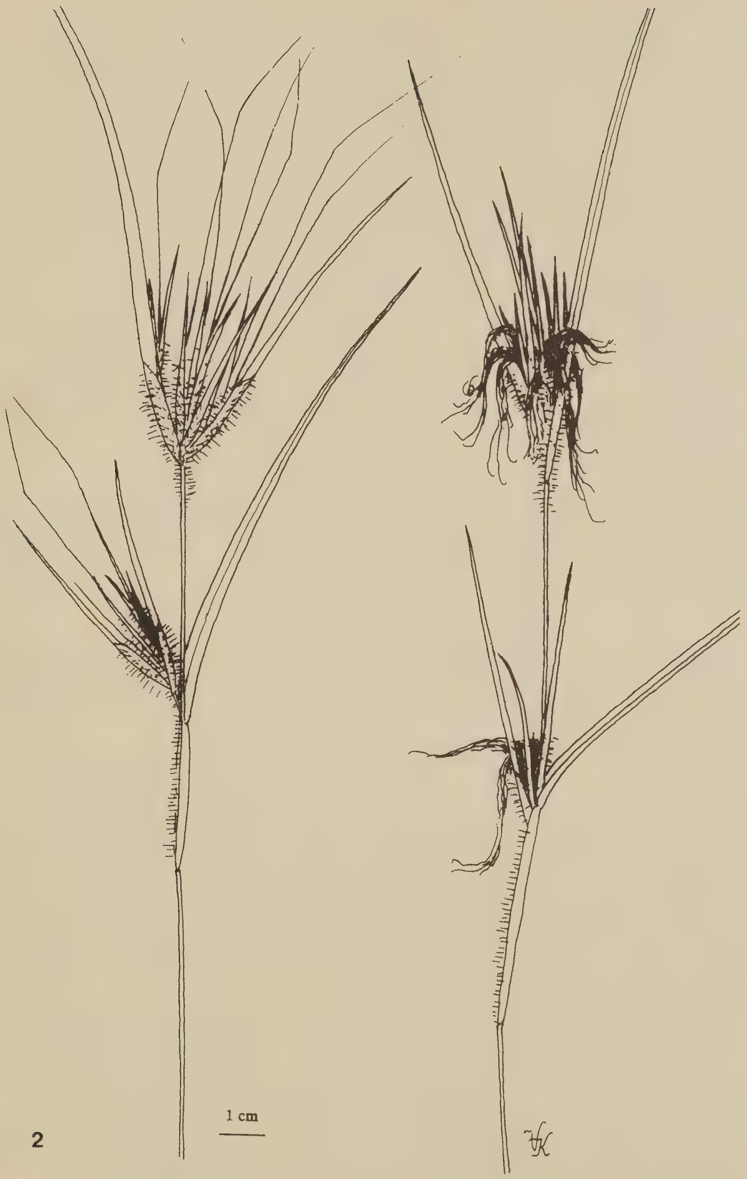

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Fig. 2. Sori of Sporisorium themedae-arguentis on Themeda arguens. A healthy and an infected plant (type).

sporarum (Fig. 6) ovoidei, elongati, sed plerumque irregulares, 20–40 x 20–60 µm, rufobrunnei, semi-permanentes, e sporis (3–)8–35? conspicue laxe connectis formati. Sporae (Figg. 6, 7) subglobosae, ovoideae usque sub-multiangulate irregulares, 9–12 x 11–15(–17) µm, rufobrunneae; paries sporarum externarum inaequaliter incrassatus (0,5–1,5 µm), parte libera superficiei spinis asperis laxe dispositis, cca. 1 µm altis instructa. Paries sporarum internarum glomerulorum majorum aequalis, tenuis (cca. 0,5 µm), conspicue levis vel leniter, sparse punctatus.

Sori (Fig. 2) comprising all spikelets of a raceme, cylindrical, at first covered by a pale brown membrane which disintegrates early disclosing the black, powdery mass of spore balls and several, up to 50 mm long, filiform columellae of host tissue origin. All racemes of an inflorescence are affected. Sorus membrane composed of several layers of tightly packed chains of elongated, subangular, thin-walled, pale yellowish-brown fungal cells of 4–7(–9) x 5.5–20 µm. Spore balls (Fig. 6) ovoid, elongate, usually irregular, 20–40 x 20–60 µm, reddish-brown, semipermanent, composed of (3–)8–35?, apparently loosely connected spores. Spores (Figs. 6, 7) subglobose, ovoid to subpolyhedrally irregular, 9–12 x 11–15(–17) µm, reddish-brown; wall of outer spores unequally thickened (0.5–1.5 µm), free surface provided with sparsely situated, coarse spines of c. 1 µm height; wall of inner spores of larger balls uniform, thin (c. 0.5 µm), apparently smooth or sparsely, finely punctate.

A smut which destroys the whole inflorescence of Themeda avenacea has often been called Ustilago condigna H. Sydow (= Sporisorium exsertum), probably because of the inexact original description of the sori of U. condigna (for comments see S. exsertum). The spores and the sori of the following smut are markedly different from those of S. exsertum. This fungus is described here as:

Sporisorium langdonii K. Vánky, **sp. nov.**

Typus in matrice Themeda avenacea (F. v. M.) Maid. & Betche., Australia, Queensland, Dalby, 27.V.1941, R. F. Langdon (BRIP 7865!); isotypus in BPI 159677! (as Ustilago condigna). Paratypus in matrice Themeda cf. avenacea, Australia, Queensland, Roma, State Farm, leg. ? (BRIP 7867! ex BRIU 837 ex Pathol. Herb. Qld. Dept. Agric.).

Sori (Fig. 3) inflorescentiam totam occupantes, per spathas partim obtecti, cca. 5 x 30–60 mm, primo membrana tenui, cinerescenti cooperti, post desintegrationem membranae massam sporarum pulveream, atrobrunneam, cum cellulis sterilibus et columellis pluribus longis, filiformibus origine matricalibus mixtam ostendentes. Sporae (Figg. 8, 9) immaturae in glomerulis magnis, irregularibus, polysporis, maturae solitariae, globosae, subglobosae, ovoideae usque elongatae, 7–9 x (7–)8–11(–12) µm, olivaceobrunneae; pariete aequali, cca. 1 µm crasso, densiuscule punctato-verruculoso. Cellulae steriles singulae, globosae, subglobosae, ovoideae, saepe collapsae, magnitudine variae, vulgo sporis majores (8–18 µm longae), subhyalinae usque pallide flavido-brunneae, pariete levi, 1–1,5 µm crasso.

Sori (Fig. 3) comprising the whole inflorescence, partly hidden by the spathes, about 5 x 30–60 mm, at first covered by a thin greyish membrane which disintegrates revealing a dark brown, powdery mass of spores intermixed with sterile cells and numerous, long, filiform columellae of host origin. Spores (Figs. 8, 9) when young in large, irregular, many-spored balls, when mature single, globose, subglobose, ovoid to elongate, 7–9 x (7–)8–11(–12) µm, olivaceous-brown; wall uniform, c. 1 µm thick, finely, moderately densely punctate-verruculose. Sterile cells single, globose, subglobose, ovoid, often collapsed, variable in size, usually larger than the spores (8–18 µm long), subhyaline to pale yellowish-brown, wall 1–1.5 µm thick, smooth.

This fungus is named in the honour of the excellent Australian mycologist, late Dr. R. F. N. Langdon, who collected the type specimen.

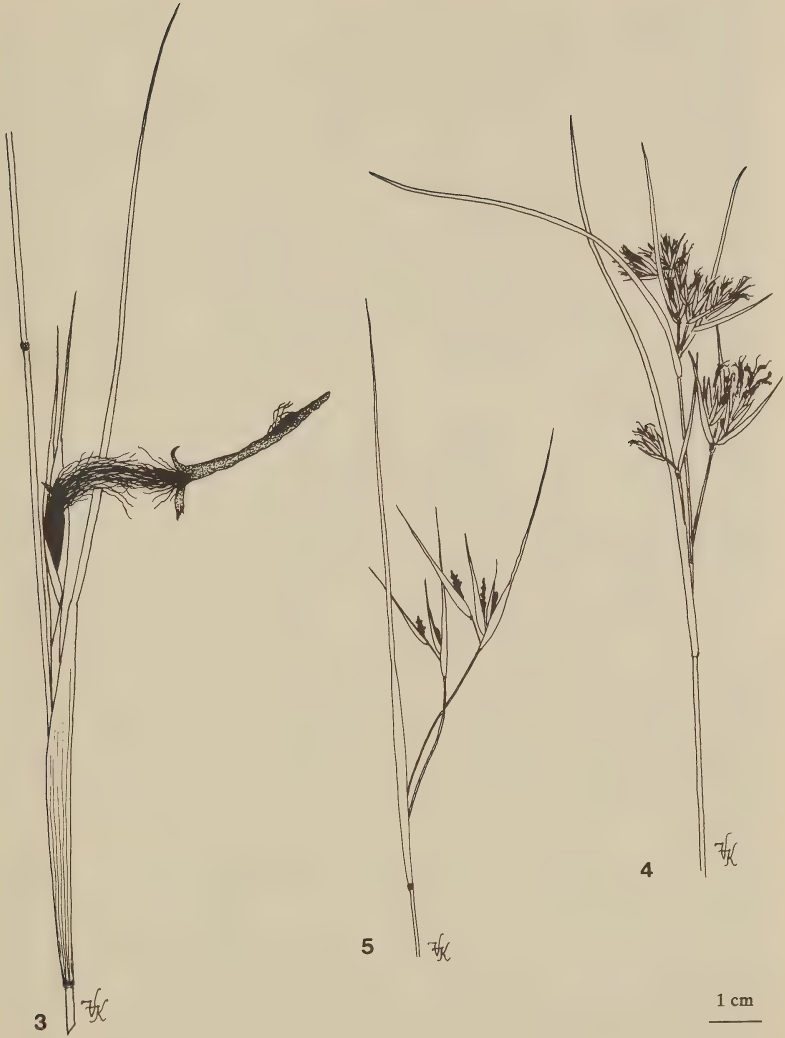


Fig. 3. Sori of Sporisorium langdonii on Themeda avenacea (type).
Fig. 4. Sori of Sporisorium walkerii on Themeda australis (type).
Fig. 5. Sori of Sporisorium lingii on Themeda australis (type).

Sporisorium walkerii K. Vánky, **sp. nov.**

Typus in matrice Themeda australis (R. Br.) Stapf (= T. triandra Forsskål), Australia, N.S.W., Sydney, North Parramatta, 9.XI.1983, leg. J. Walker (DAR 45948!, as Sorosporium anthistiriae). Paratypus in matrice Themeda australis, Australia, Fernvale, 15.XI.1965, leg. R. F. Langdon (BRIP 7876! ex BRIU 2454).

Sori (Fig. 4) spiculas centrales racemorum destruentes sed spiculas involucrales intactas concedentes, cylindrici, 1 x 8–12 mm, primo cooperti peridio fungali flavobrunneo, post disruptionem peridii longitudinalem massam primo agglutinatam, serius granulosam-pulveream glomerulorum sporarum atque columellas nonnullas longas, filiformes, origine matricales ostendentes. Glomeruli sporarum (Fig. 10) forma magnitudineque varii, subglobosi, ovoidei, elongati vel irregulares, (25–)30–70 x (30–)40–80 µm, atro-rufobrunnei, opaci, satis permanentes, e duodenis nonnullis sporarum usque plusquam centum sporis compositi. Sporae (Figg. 10, 11) subglobosae usque ellipsoideae, internae earum forte submultiangulariter irregulares, 7–11 x 8–14 µm, atro-rufobrunneae, paries sporarum externum parum inaequaliter incrassatus, superficie libera tenuiore (0,5–1 µm), punctata-verrucosa, raro minute echinulata, partes superficiei contingentes saepe crassiores (1–1,5, raro 2,5 µm), minute punctulatae usque conspicue leves, sicut illae sporarum centralium. Peridium compositum e catenis arcte iunctis cellularum fungalium 4–6,5 x 5,5–20 µm, hyalinarum, elongatarum vel subtetrangularium.

Sori (Fig. 4) destroying the central spikelets of the raceme leaving intact the involucral spikelets, cylindrical, 1 x 8–12 mm, first covered by a yellowish-brown fungal peridium which ruptures longitudinally exposing the black, first agglutinated, later granular-powdery mass of spore balls and several long, filiform columellae of host origin. Spore balls (Fig. 10) variable in shape and size, subglobose, ovoid, elongate or irregular, (25–)30–70 x (30–)40–80 µm, dark reddish-brown, opaque, rather permanent, composed of a few dozen to over a hundred of spores. Spores (Figs. 10, 11) subglobose to ellipsoidal, inner spores may be subpolyhedrally irregular, 7–11 x 8–14 µm, dark reddish-brown; wall of outer spores slightly unevenly thickened, free surface thinner (0.5–1 µm), punctate-verruculose, rarely finely echinulate, contact sides often thicker (1–1.5, rarely 2.5 µm), finely punctate to apparently smooth, like those of central spores. Peridium composed of tightly packed chains of hyaline, elongated, subtetrangular fungal cells measuring 4–6.5 x 5.5–20 µm.

Sporisorium walkerii is close to the South African S. holstii on Themeda triandra from which it differs in having smaller spore balls and spores. S. walkerii has finer ornamentation of the spores. Its outer spores are punctate-verruculose, rarely finely echinulate whereas those in S. holstii are prominently echinulate.

This smut was treated by McAlpine (1910:126 & 186, Pl. VII) under the name of Tolyposporium bursum (Berk.) McAlpine. This error was discovered already by Zundel (1953:148).

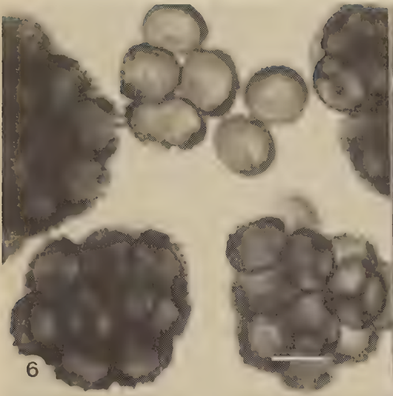
Other specimens in DAR (Nos. 605, 1093, 2191, 45948, 64671, 64672) and in BRIP (Nos. 7851, 7853, 7856, 7874, 7876), unidentified or preserved under different names, all on Themeda australis from Australia, represent Sporisorium walkerii, except DAR No. 1093 which contains both S. walkerii and S. exsertum on the same host plant.

S. walkeri is named in the honour of the excellent Australian phytopathologist, Prof. John Walker (Rydalmere, N.S.W.), the collector of the type specimen.

Figs. 6, 7. Spore balls and spores of Sporisorium themedae-arguentis in LM and SEM (type).

Figs. 8, 9. Spore balls and spores of Sporisorium langdonii in LM and SEM (type).

Figs. 10, 11. Spore balls and spores of Sporisorium walkerii in LM and SEM (type).
bars = 10 µm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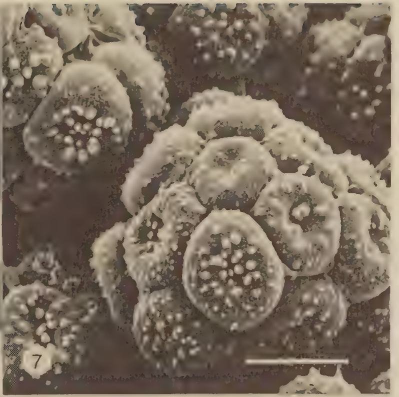
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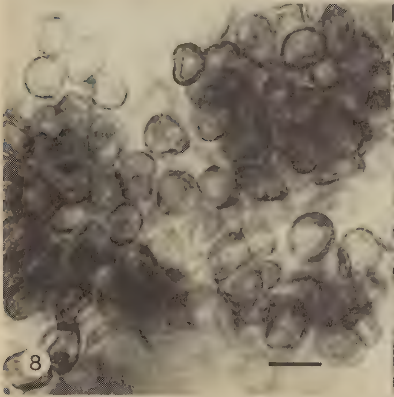
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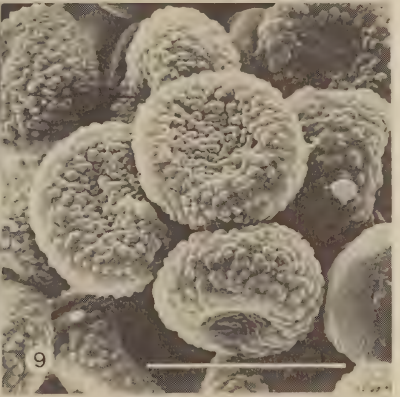
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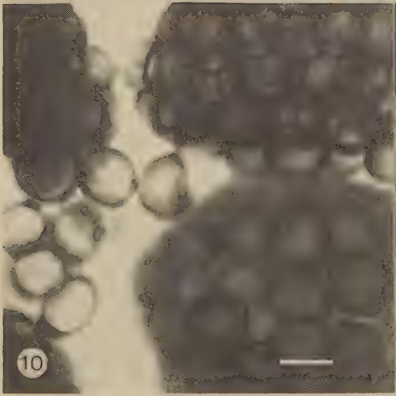
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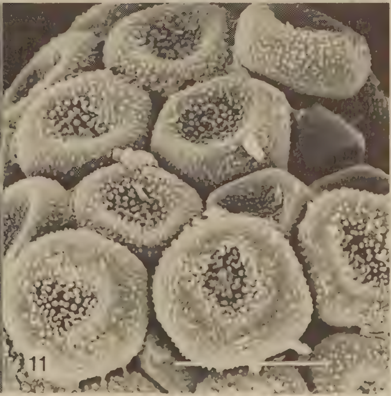

11

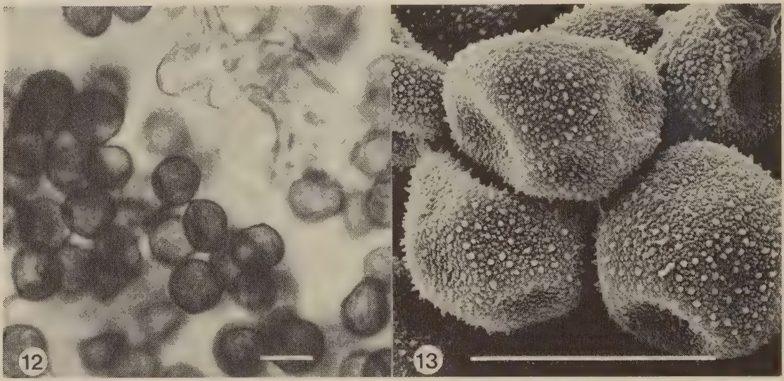
Sporisorium lingii K. Vánky, **sp. nov.**

Typus in matrice *Themeda australis* (R. Br.) Stapf (= *T. triandra* Forsskål), Australia, Mt. Mitchell, 5.VII.1952, leg. D. McColm (BRIP 7854! ex BRIU 563, as *Sorosporium anthistiriae*). Paratypus in matrice *Themeda australis*, Australia, New South Wales, Prospect, V.1931, leg. L. Fraser (DAR 1092!, as *Cintractia exserta*).

Sori (Fig. 5) illis *Sporisorii exserti* congruentes, racemos totos destruentes, cum columella singulari centrali, ramificta, sed sporis (Figg. 12, 13) majoribus: 7,5–10 x 8–12 µm (illae *Sporisorii exserti*: 5,5–8 x 6–9,5 µm). Cellulae steriles sporis majores, 12–25 µm longae, catenatae vel acervatim dispositae.

Sori (Fig. 5) as in *Sporisorium exsertum*, comprising the entire racemes, with a single, central, branched columella, but the spores (Figs. 12, 13) are larger measuring 7.5–10 x 8–12 µm (those in *S. exsertum* are 5.5–8 x 6–9.5 µm). Sterile cells larger than the spores, 12–25 µm long, in chains or irregular groups.

This fungus is named in the honour of the excellent ustilaginologist Lee Ling, the author of "The Ustilaginales of China", 1953, and of several taxonomical papers of high value on different groups of smut fungi, including several *Themeda*-smuts. Judged from the few specimens preserved in different herbaria, *Sporisorium lingii* is more rare than the frequently collected *S. exsertum*.



Figs. 12, 13. Spores and sterile cells of *Sporisorium lingii* in LM and SEM (type; bars = 10 µm).

Sporisorium anthistiriae (Cobb) K. Vánky, in Vánky & Guo, 1987:230.

Tolyposporium anthistiriae Cobb, 1892:1006. – *Sorosporium anthistiriae* (Cobb) Ling, 1945:9. – Type on *Anthistiria ciliata* L. fil. (= *Themeda quadrivalvis* (L.) O. Kuntze), Australia, New South Wales.

Tolyposporium anthistiriae P. Hennings, 1898:283, (later homonym, non Cobb, 1892) on *Anthistiria* sp., Central Africa, Djur, "gr. Seriba Ghattas-Steppe", 30.V.1869, G. Schweinfurth (BPI 192686!, 195174).

Sori in scattered ovaries, cylindrical, often slightly bent, 1.5–2 x 10–30 mm, at first covered by a yellowish membrane which ruptures longitudinally exposing the black, granular-powdery mass of spore balls and several filiform columellae. Spore balls rather permanent, variable in shape and size, ovoid to usually elongated or irregular, 30–170 µm long, reddish- to blackish-brown, composed of a few dozen to several hundred spores. Outer spores globose, subglobose, ovoid to slightly irregular, 8–12 x 9–14 µm, dark reddish-brown; wall even, 1–1.5 µm thick, free surface densely, moderately coarsely verruculose-echinulate. Inner spores polyhedrally irregular, yellowish-brown, thin-walled (c. 0.5 µm), apparently smooth.

Type not seen. Description based on Vánky, Ust. 579, and on several other specimens, including P. Hennings' *Tolyposporium anthistiriae*.

Sporisorium anthistiriae is close to *S. holstii* but differs from it in having ovaricolous sori (awn present!) and an evenly thickened, more finely ornamented wall of the outer spores. *S. holstii* has sori in the spikelets of a raceme (awn destroyed!), the wall of the outer spores is thick (1–3 µm), uneven and prominently echinulate on the free surface.

Sporisorium benguetense (Zundel) L. Guo, 1990:76.

Sphacelotheca benguetensis Zundel, 1943:175. – Type on *Themeda triandra* Forsskål, Philippines, Island of Luzon, Subprovince Benguet, V.1911, E. D. Merrill, Flora of the Philippine Islands No. 7908 (Bureau of Science, Manila, P. I., as "*Ustilago bursa* Berk."; BPI 177262!).

Sori comprising the racemes, cylindrical, 1 x 10–20 mm, covered by a dark brown membrane of sterile cells which disintegrates from the apex exposing a blackish-brown, semi-powdery spore mass surrounding a long, simple columella. Spores when mature single, subglobose, broadly ellipsoidal to subpolyhedrally irregular, 10.5–13 x 11–14.5 µm, olivaceous-brown; wall uniform, c. 1 µm thick, minutely, sparsely to moderately densely echinulate. Sterile cells in small groups, about the same size as the spores or larger (11–18 µm long), subhyaline to pale yellowish-brown, smooth, collapsing with age.

Zundel (1943:174) described this species as having sori in the ovaries. However, I belive that the sori comprise the whole raceme, because I was unable to find involucral spikelets in the scanty type material from BPI.

Sporisorium enteromorphum (McAlpine) K. Vánky, **comb. nov.**

Basionym: *Ustilago enteromorpha* McAlpine, Agric. Gaz. New South Wales 7:154, 1896. – *Sorosporium enteromorphum* (McAlpine) McAlpine, 1910:177. – Type on *Anthistiria ciliata* L. fil. (= *Themeda quadrivalvis* (L.) O. Kuntze), Australia, Victoria, near Melbourne, X. & XI.1892, G. H. Robinson. (In BPI 179841! "on *Anthistiria australis*, Burnley Gardens, 21.XII.1892, G. H. Robinson").

Sori may comprise the central spikelets, the racemes ("intestinal-shaped", 0.1–0.2 x 1.2–2.5 cm) or the inflorescence (long linear or flagelliform, 0.2–0.3 x 5–11 cm), first covered by a greyish-brown fungal membrane which disintegrates exposing a dark brown, granular-powdery mass of spore balls intermixed with groups of sterile cells and several, filiform columellae. Spore balls subglobose, oblong or irregular, 20–45 x 25–60(–80) µm, many-spored, disintegrating at maturity. Spores subglobose, ovoid to slightly irregular, 5–7 x 5.5–8 µm, yellowish-brown; wall uniform, thin (c. 0.5 µm) finely punctate-verrucose. Sterile cells somewhat larger than the spores (8–12 µm long), in short chains or irregular groups, subhyaline, collapsed in old specimens.

Sporisorium exsertum (McAlpine) L. Guo, 1990:80.

Cintractia exserta McAlpine, 1910:170. – *Sphacelotheca exserta* (McAlp.) Ciferri, 1928:32. – Lectotype on *Anthistiria ciliata* L. fil. (= *Themeda quadrivalvis* (L.) O. Kuntze), Australia, Victoria, (selected by Zundel, 1953:91) Kiewa Valley, XI.1902, Robinson (BPI 32225!, as on "*Anthistiria australis*" = *Themeda australis* (R. Br.) Stapf. The identity of the host plant could not be verified on the diseased, destroyed racemes, preserved in BPI).

Ustilago anthistiriae Petch, 1909:304 (non *Sporisorium anthistiriae* (Cobb) K. Vánky). – *Sphacelotheca anthistiriae* (Petch) Ling, 1953:328. – Type on *Anthistiria tremula* Nees ex Steud. (= *Themeda tremula* (Nees ex Steud.) Hack.), Ceylon (Sri Lanka), Peradeniya, 10.V.1908, T. Petch (BPI 157285, 157286!).

Sphacelotheca vryburgii Zundel, 1931:298. – Type on *Themeda forskalii* Hack. (= *T. triandra* Forsskål), Union of South Africa, British Bechuanaland, Vryburg, 5.V.1916, I. B. Pole Evans (BPI 195083!).

Ustilago condigna H. Sydow, 1938:293. – Type on Themeda avenacea (F. v. M.) Maid. & Betche., South Australia, Coniston, VIII.1936, J. B. Clealand.

Sori comprising the entire racemes, 1–2 x 4–16 mm, cylindrical but often with short, appressed, lateral, spikelet-like branches, at first covered by a yellowish-brown membrane which flakes away disclosing a single, central, branched columella surrounded by a blackish-brown, agglutinated mass of readily disintegrating, large, irregular, many-spored spore balls (of up to several hundred spores) intermixed with small groups or chains of sterile cells. Spores globose, ovoid to subpolyhedrally irregular, 5.5–8 x 6–9.5 µm, yellowish-brown; wall even, thin (c. 0.5 µm), ornamentation, depending on initial position of spore in spore ball, ranging from apparently smooth to very finely or evidently, moderately densely punctate-verruculose. Sterile cells subglobose to irregular, larger than the spores (8–18 µm long, collapsed in old specimens), subhyaline, wall 1–1.5 µm thick, smooth.

The type of U. condigna probably does not exist any longer. I agree with Ling (1953:328) considering U. condigna a synonym of Sphacelotheca anthistiriae (Petch) Ling (= Sporisorium exsertum). As Sydow (1938:293) wrote, he could not give an accurate description of the sori of Ustilago condigna because the original material was scanty. (Sori seem to infect the young panicles, which are hidden by leaves, converting each panicle into a more or less elongate body of up to 2 cm long and about 0.5 cm wide, at first covered by a thick, yellowish membrane). The description of the spores, given by Sydow (Spores globose, subglobose or broadly ellipsoidal, often somewhat angular, smooth, yellowish-brown, 6–8 µm, rarely up to 10 µm long and 4.5–7 µm wide) agrees with that of S. exsertum. From the original description it is not clear if the sori of U. condigna comprise the racemes or the whole inflorescence. Judged from the size of the sori, given by Sydow, and the presence of a thick peridium, the sori in Sydow's species are restricted to the racemes.

Sporisorium holstii (P. Hennings) K. Vánky, **comb. nov.**

Basionym: Sorosporium holstii P. Hennings, Ustilagineae. In Engler, A. (ed.) Die Pflanzenwelt Ost-Afrikas und der Nachbargebiete. Teil C, Berlin, 1895, p. 49. – Type on Themeda forskalii Hack. (= T. triandra Forsskål), Tanganyika Terr., Usambara, 1893, C. Holst (no. 3111a, as Anthistiria glauca = Themeda triandra; HUV 12098!, BPI 180025, 180027, 195134).

Sori comprising all or only the central spikelets of the raceme, cylindrical, tapering at base and apex, 1–1.5 x 10–20 mm, at first covered by a yellowish-brown membrane which ruptures longitudinally exposing the black, granular-powdery mass of spore balls and several filiform columellae. Spore balls rather permanent, variable in shape and size, ovoid to irregular, often rather angular, (35–)50–130 µm long, dark reddish- to blackish-brown, opaque, composed of a few dozen to several hundred spores. Spores ovoid to usually irregular, 9.5–13 x 12–14.5 µm, dark reddish-brown; outer spores prominently echinulate on their free surface where the wall is thin (c. 0.5 µm), spines c. 1 µm high, on contact sides the wall is uneven, 1–3 µm thick, smooth.

Sporisorium indehiscens (L. Ling) K. Vánky, **comb. nov.**

Basionym: Sphacelotheca indehiscens L. Ling, Sydowia 3:125, 1949. – Type on Themeda gigantea (Cav.) Hack., Java, Lawang, Mt. Buysman (BPI !).

Sori in the spikelets, cylindrical, 1–1.5 x 5–8 mm, partially concealed by the glumes, each enclosed by a thick, greyish-brown fungal membrane composed of 10 or more layers of firmly united sterile cells, usually indehiscent. Columella inconspicuous, single, unbranched, much shorter than the sori. Spores subglobose, ellipsoidal to slightly angular, 11–13.5 x 12.5–18 µm, deep reddish-brown, semiopaque; wall c. 1 µm thick, finely pitted. Sterile cells subglobose to angular, 6–10.5 µm in diameter, hyaline; wall 1–1.5 µm thick, smooth.

Sporisorium punctatum (L. Ling) K. Vánky, **comb. nov.**
Basionym: Sphacelotheca anthistiriae (Petch) L. Ling var. punctata L. Ling, Farlowia 4:328, 1953. – Type on Themeda triandra Forsskål, China, Szechwan, Chengtu, XI.1947, K. R. Lin (BPI !).

Sori comprising the racemes, columella simple, spore mass dark brown, powdery. Spores when mature single, globose, subglobose, ovoid to subpolyhedrally irregular, 7–9.5 x 7–11 µm, light brown; wall even, c. 0.8 µm thick, from apparently smooth to sparsely or moderately densely punctate. Sterile cells in irregular groups, subglobose, ovoid to irregular, larger than the spores (10–21 µm long), pale yellow, smooth, collapsed in old specimens.

Sporisorium punctatum differs from S. themedicolum and S. exsertum in having larger spores. S. exsertum has also more evidently ornamented spores than S. punctatum.

Sporisorium themedae (Duke) K. Vánky, **comb. nov.**
Basionym: Sphacelotheca themedae Duke, Bull. Misc. Inform. 8:315, 1926. – Type on Themeda triandra Forsskål, Kenya, Nairobi, 14.V.1916, W. J. Dowson (BPI 195087!).

Sori comprising the racemes, elongated, about 15 mm long, 1 mm wide, at first covered by a yellowish-brown peridium which dehisces from its apex exposing a dark brown, powdery mass of spores intermixed with groups of sterile cells and a simple, central columella tapering toward its apex. Exceptionally, the columella may bifurcate or have 1–2 short, lateral branches. Spores when mature single, globose, subglobose to ovoid, 8–10.5 x 9.5–12 µm, yellowish-brown; wall even, c. 0.8 µm thick, moderately densely, finely verrucose-echinulate. Sterile cells in irregular groups, easily separating, globose or ovoid, often collapsed, 10–15 µm long, pale yellowish-brown, smooth, homogeneous.

Sporisorium themedicolum (L. Ling) K. Vánky, **comb. nov.**
Basionym: Sphacelotheca themedicola L. Ling, Sydowia 5:44, 1951. – Type on Themeda gigantea (Cav.) Hack., Philippines, Luzon, Zambales province, Anuling, XI-XII.1924, M. Ramoss & G. Edano (Herb. Bureau Sci. Phil. 44578; BPI 192078!).

Sori destroying each solitary raceme of the inflorescence, when young more or less enveloped by the spatheole, later protruding beyond it, narrowly ellipsoidal, 1–1.5 x 3–5 mm, at first covered by a thin, greyish, fungal membrane, which flakes away at maturity disclosing a dark brown, dusty spore mass intermixed with small, irregular groups of sterile cells. After the dispersion of the spores a simple, flagelliform, central columella of host origin is left behind. Spores when mature single, globose, subglobose to ovoid, 4.5–5.5(–6) x 5–7 µm, light olivaceous-brown; wall uniform, c. 0.5 µm thick, from apparently smooth to finely and sparsely punctate. Sterile cells much larger than the spores (8–18 µm long), subglobose, ovoid or compressed on one or two sides, pale yellowish-brown, with a 1–1.5 µm thick, smooth wall.

The following two species probably belong to the genus Neovossia. However, new combinations are best put off pending clarification of generic delimitations for Tilletia and Neovossia.

Tilletia themedae-anatherae Pavgi & Thirumalachar, 1955:89.
Type on Themeda anathera (Nees) Hack., India, Uttar Pradesh, Mussorie, 24.X.1953, M. S. Pavgi.

Sori in scattered ovaries, elongated, slightly curved, 1.5–2 x 10–15 mm, covered by the pericarp, which encloses the somewhat agglutinated, black spore mass. Mature spores globose, subglobose to slightly irregular, 18.5–24.5 µm in diameter, pale brown to blackish-brown, opaque; wall 1.5–2.5 µm thick, covered by truncate scales 1.5–2.5 µm high, which in median view form a lighter coloured band with irregular margin. Sterile cells globose to subglobose, 11–27 µm in diameter, dirty yellowish, with a a thin or thick (1.5–4 µm), often laminated, smooth wall.

Type not seen. The description is taken from the original and from Durán & Fischer (1961:84), who considered T. themedae-anatherae a synonym of T. narayanaraoana Mundkur & Thirumalachar (type on Panicum trypheron Schult.).

Tilletia themedicola Mishra & Thirumalachar, in Thirumalachar & Mishra, 1953:82.

Type on Themeda quadrivalvis (L.) O. Kuntze, India, Bihar, Parasnath, 10.XII.1952, J. N. Mishra (HCIO 20169!, BPI 173902!).

Sori in scattered ovaries, ovoid, 2–4 x 8–12 mm, dark brown with a yellowish-brown apex where the sori rupture disclosing the black, powdery mass of spores of different grade of maturity. Spores globose, subglobose to ovoid, 18–26 x 19–28 µm, from light yellowish-brown to dark reddish-brown (depending on degree of maturity), sometimes with a short, hyaline papilla or appendage; wall 3–4 µm thick (including ornamentation), provided with densely situated, 1–1.5 µm high warts. Sterile cells few, intermixed with spores (not to be confused with immature spores with traces of ornamentation and pigmentation), globose, subglobose to slightly irregular, 8–20 µm in diameter, subhyaline, wall 2–4 µm thick, smooth.

Ustilago bursa Berkeley, 1854:206.

Tolyposporium bursum (Berk.) McAlpine, 1910:186. – Sphacelotheca bursa (Berk.) Mundkur & Thirumalachar, 1946:6. – Sporisorium bursum (Berkeley) K. Vánky, 1988:403. – Type on Anthistiria arundinacea Roxb. (= Themeda arundinacea (Roxb.) Ridley), India, Sikkim (Herb. Berkeley No. 4733 in K!).

Sori in scattered ovaries at first as green, elongate, later as greenish- or yellowish-brown, ovoid or subglobose, 4–5 mm long bodies, gradually narrowed into a short pedicel, abruptly contracted into an acute, yellow, 1–2.5 mm long apex, the remnant of the distal part of the caryopsis. Sori covered by a membrane which ruptures irregularly to expose the dark brown, powdery mass of spores intermixed with irregular, loose groups of sterile cells. The sorus membrane is composed of an external layer of host origin, and an internal, often incomplete layer of fungus origin. Columella absent but a white mass of fungal cells fills the pedicel and basal part of young sori. From this mass of fungal cells arises the internal layer of the sorus membrane and probably also the spores and groups of sterile cells. Spores when young agglutinated in irregular, many-spored groups, later single, globose, subglobose to broadly ellipsoidal, 8–11 x 9–12(–13) µm, light brown; wall uniform, c. 0.8 µm thick, sparsely, evidently echinulate, spines c. 1 µm high. Sterile cells subglobose, ovoid to somewhat irregular, smaller than the spores, 6–8(–10) µm long, hyaline, with granular contents and a thin (c. 0.5 µm), smooth wall.

On herbarium labels and in the literature this smut was often confused with other Themeda-smuts. A recent, rich collection from India (Vánky, Ustilaginales exs. 844), identical with Berkeley's type, permitted a detailed study and the above description of this smut. Its generic position is intermediate between Ustilago and Sporisorium. The presence of one or several columellae, composed of host tissue and (at least in young stages) fungal elements, is typical for Sporisorium. This is lacking in U. bursa. The presence of groups of sterile cells intermixed with spores is not proper for Ustilago but is typical for many Sporisorium species. It is interesting that the sorus structure of Ustilago bursa is rather similar to that of U. spermophora Berkeley & Curtis ex de Toni, in Saccardo, 1888:466, on different Eragrostis species. On the basis of the sorus structure, Moesz (1921:63) transferred U. spermophora into the genus Sphacelotheca (a genus which today is reduced to certain Polygonaceae smuts). U. spermophora differs from U. bursa, i. a., in having more finely echinulate spores.

Sporisorium sp.

The manuscript of this paper was nearly finished when I got 34 smutted *Themeda* specimens from BRIP (Plant Pathology Herbarium, Department of Primary Industries, Indooroopilly, Australia) for revision and identification. Between these, an unidentified smut on *Themeda australis* turned out to be distinct. It has sori in the racemes, somewhat similar to the sori of *Sporisorium exsertum*, but the columella rather often is unbranched. The spore measurements (6–8.5 x 6.5–9.5 µm) are also close to those of *S. exsertum* (5.5–8 x 6–9.5 µm) but the spores are much darker and possess a relatively very thick wall (1.5–2.5 µm), unlike any other *Themeda*-smut of this spore size.

A formal description and illustration of this smut will be published later.

The main differences of the *Themeda*-smuts are presented in the following key:

1. Spores more than 18 µm long 2
– Spores less than 18 µm long 3
2. Sori ovoid, 8–12 mm long . . . . *Tilletia themedicola*
– Sori elongated, slightly curved, 10–15 mm long . *Tilletia themedae-anatherae*
3. Columella absent, sori globoid, apiculate . . . . *Ustilago bursa*
– Columella present, sori not so 4
4. Columella one 5
– Columellae several, filiform 12
5. Columella branched 6
– Columella simple, unbranched 8
6. Spores 6–9.5 µm long 7
– Spores 8–12 µm long . . . . *Sporisorium lingii*
7. Spore wall thin (c. 0.5 µm) . . . . *Sporisorium exsertum*
– Spore wall thick (1.5–2.5 µm) . . . . *Sporisorium* sp.
8. Spores 5–7 µm long, punctate . . . . *Sporisorium themedicolum*
– Spores larger 9
9. Spores 7–11 µm long, punctate . . . . *Sporisorium punctatum*
– Spores larger 10
10. Spores 9–12 µm long, verrucose-echinulate . . . . *Sporisorium themedae*
– Spores larger 11
11. Spores 11–14.5 µm long, minutely echinulate. Sterile cells about the same size as the spores or larger. Sori 10–20 mm long . . . *Sporisorium benguetense*
– Spores 12.5–18 µm long, finely punctate. Sterile cells smaller than the spores. Sori 5–8 mm long . . . . *Sporisorium indehiscens*
12. Sori comprise the whole inflorescence 13
– Sori not so 14
13. Spores 5.5–8 µm long . . . . *Sporisorium enteromorphum*
– Spores (7–)8–11(–12) µm long . . . . *Sporisorium langdonii*
14. Sori restricted to the ovaries (awn present) . . . . *Sporisorium anthistiriae*
– Sori comprise the racemes (awn absent) 15
15. Spores 5.5–8 µm long . . . . *Sporisorium enteromorphum*
– Spores 11–15 µm long 16
16. Spore balls 20–60 µm long, rather loose, composed of (3–)8–35? spores . . . . *Sporisorium themedae-arguentis*
– Spore balls larger, rather permanent, composed of many more spores 17
17. Spore balls 35–130 µm long, free surface of outer spores prominently echinulate . . . . *Sporisorium holstii*
– Spore balls 30–80 µm long, free surface of outer spores punctate-verruculose to finely echinulate . . . . *Sporisorium walkerii*

Anthracoidea altiphila K. Vánky & M. Piepenbring, **sp. nov.**
Typus in matrice Carex jamesonii Boott (subgen. Carex, sect. Fecundae), Costa Rica, Prov. Cartago, Mts. Cordillera de Talamanca, 38 km S. Cartago, inter pagg. Canon et Trinidad, 9°41’ N, 83°55’ W, alt. ca. 2630 m, 5.III.1991, leg. P. Döbbeler, J. Gómez-Laurito, T. & K. Vánky. Holotypus in Herbario Ustil. Vánky (HUV 15786); isotypi in Vánky, Ustilaginales exsiccata no. 901. Paratypus in matrice Carex pichinchensis Kunth (sect. Fecundae), Ecuador, Prov. Pichincha, 17 km S. W. Quito, inter pagg. Chilliogallio et San Juan, 0°16’ S, 78°36’ W, alt. ca. 3320 m, 4.III.1993, leg. C. Menge, R. Berndt, H. Bauch & K. Vánky (HUV 15787); isoparatypi in Vánky, Ustilaginales exsiccata no. 902. Paratypi in matrice Carex jamesonii Boott, Costa Rica, Prov. Cartago, Mts. Cordillera de Talamanca, 71 km S. San José, alt. ca. 2700 m, 29.III.1991, leg. T. & K. Vánky; isoparatypus in BPI. Paratypus in matrice Carex jamesonii var. chordalis (Liebm.) Kük. (C. chordalis Liebm.; sect. Fecundae), Colombia, Dpto. Huila, Parque Arqueologico Nacional San Augustin, ca. 37 mi. from Pitalito, 20.I.1976, K. P. Dumont (3222), P. Buriticá (76-216), J. L. Luteyn & L. A. Molina (HUV 15789!).

Sori (Fig. 15) in ovariis, subglobosi, 1–2 mm diametro, primo membrane cinerescenti, origine fungali cooperti, deinde post desintegrationem membranae unumquidque sicut massa semiagglutinata sporarum expositi. Sporae (Figg. 18, 19) subglobosae, ovoideae, plerumque submultiangulate irregulares, 12–16 x 13–20(–22) µm, rufobrunneae; paries irregulariter incrassatus, 1,5–3(–4) µm crassus, cum areis 3–4 tenuibus (0,5 µm) sicut maculis pallidis conspicuis. In sectione media optica partes incrassatae inter duas areas tenues sicut incrassationes internae bene evolutae apparentes. Superficies sporarum leniter denseque punctata-verruculosa, quod in extrema linea vel nequaquam vel sicut linea undulata usque lenissime serrulata apparens. Germinatio (Fig. 14) secundum typum anthracoideum. Sporae recentes temperatura solita conclaviali in agaro aquoso sine intercalatione status latentis cum basidiis bicellularibus 4–5 x 60–110 µm germinantes. Utraque cellula basidii in sterigmatibus bene evolutis (2–3 x usque 12 µm) basidiosporas nonnullas, hyalinas, ovoideas, 5–6 x 10–14 µm producens.

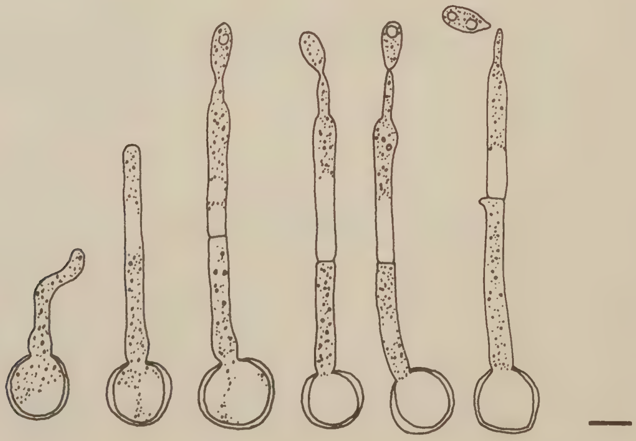


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Fig. 14. Spore germination of A. altiphila on Carex jamesonii (topotype, 30.XI.1992, M. Piepenbring 740; HUV 15819; bar = 10 µm).

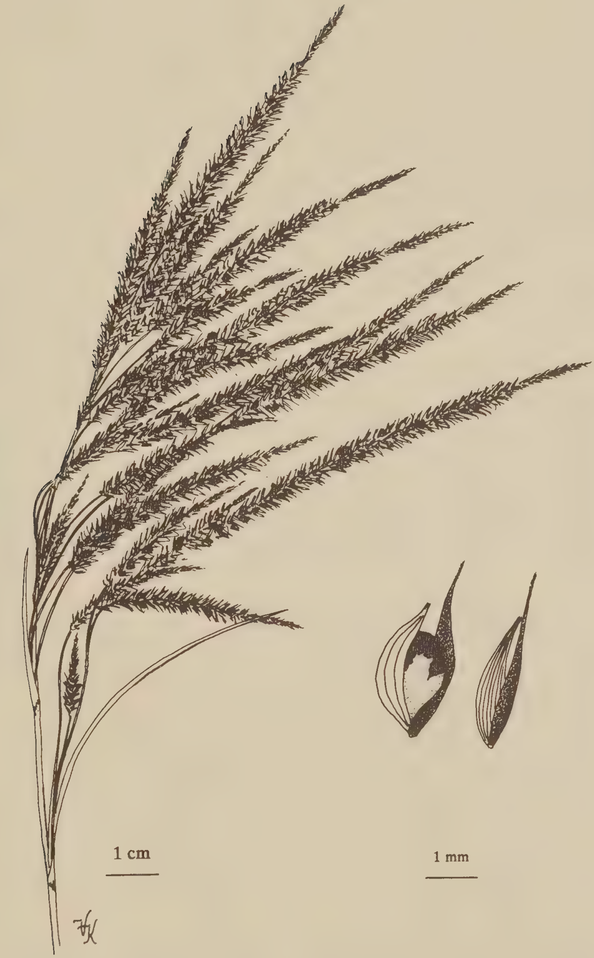

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Fig. 15. Sori of Anthracoidea altiphila in the ovaries of Carex jamesonii (type).

Sori (Fig. 15) in ovaries, subglobose, 1–2 mm in diameter, at first covered by a greyish membrane of fungal origin which flakes away exposing the black, semiagglutinated spore mass. Spores (Figs. 18, 19) subglobose, ovoid, usually subpolyhedrally irregular, 12–16 x 13–20(–22) µm, reddish-brown; wall irregularly thickened, 1.5–3(–4) µm, with 3–4 thin-walled (0.5 µm) areas appearing as light spots. In optical median view the thick-walled portions between two thin-walled areas appear as well-developed internal swellings. Surface finely and densely punctate-verruculose which does not affect the spore profile or gives it a wavy to very finely serrulate appearance. Germination (Fig. 14) of *Anthracoidea* type. Fresh spores germinate without resting period on water-agar at room temperature with 2-celled basidia of 4–5 x 60–110 µm. Each basidial cell produces several hyaline, ovoid basidiospores of 5–6 x 10–14 µm on well-developed sterigmata of 2–3 x up to 12 µm.

A. altiphila is known hitherto on different members of sect. *Fecundae* Kük. (subgen. *Carex*) collected on high mountains of Central and South America. It differs from *Anthracoidea pannucea* (Liro) Vánky on *Carex bonplandii* Kunth and *C. longii* Mack. (subgen. *Vignea*, sect. *Ovales*), from the same regions, in having larger, darker, thick-walled spores with thin-walled areas. In *A. pannucea* the spores measure 10–16 x 11–17 µm, are lighter coloured, the spore wall is 1.5–2 µm thick with 3–5 ring-shaped, thin areas. When the spores are dried these thin-walled areas collapse forming mamillate depressions (comp. Vánky 1987:17, figs. E 1, 2). Dried spores of *A. altiphila* appear subpyramidal.

The germination of *A. altiphila* is peculiar because the spores germinate without a resting period. *Anthracoidea* species from Europe and North America germinate only after overwintering outdoors. This may be explained by the fact that in Europe and North America a longer or shorter cold winter period alternates with a summer period. In the high mountains of the tropics each day is like summer and each night is like winter. Other *Anthracoidea* species from high mountains of the tropics probably also germinate without a resting period at low temperatures, as an adaptation to the climatic conditions of these places.

Tilletia polypogonis K. Vánky & N. D. Sharma, **sp. nov.**

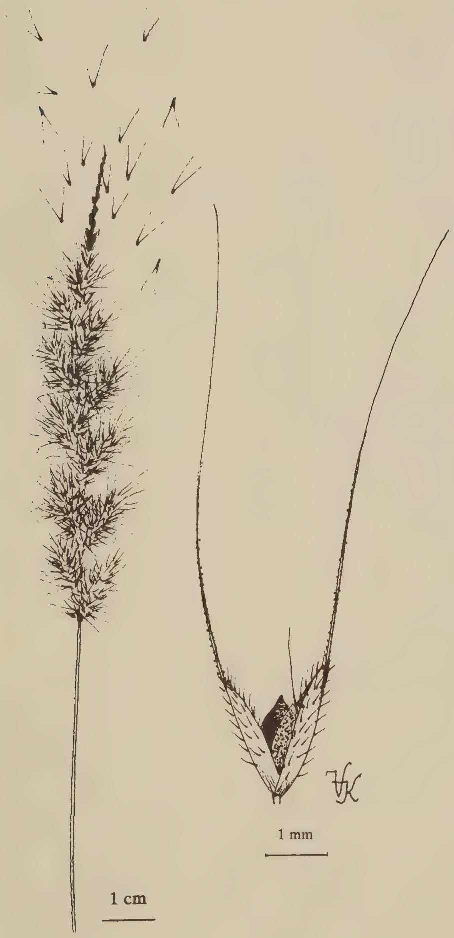
Typus in matrice *Polypogon monspeliensis* (L.) Desf., India, Madhya Pradesh, Jabalpur, Agricultural Engineering Farm, 23°10’ N, 79°57’ E, alt. c. 411 m, 19.IV.1993, leg. N. D. Sharma. Holotypus in Herbario Ustil. Vánky (HUV 15790); isotypi in Vánky, Ustilaginales exsiccata (inedited).

Sori (Fig. 16) in ovariis, ovoidei cum apiculo acuto vel limoniiformes, 0,4–0,7 x 0,7–1 mm, inconspicui, pericarpio cooperti, brunnei, integumento florali occulti. Massa sporarum semiagglutinata, pallide brunnea, e sporis et e cellulis sterilibus illis intermixtis composita. Sporae (Figg. 20, 21) subglobosae usque late ellipsoidales, 17,5–21 x 18,5–23 µm, parum flavae usque pallide flavidobrunneae; pariete valde irregulariter usque incomplete reticulato, maculis (5–)6–8 pro diametro sporae, muri inter maculas 1,5–3 µm alti, in conspectu medio optico acuti. Cellulae steriles sporis minores (10–13 µm longae), ovoideae vel modice irregulares, hyalinae, granula nonnulla continentes, pariete levi, 1–2,5 µm crasso.

Sori (Fig. 16) in ovaries, ovoid with acute tip or lemon-shaped, 0.4–0.7 x 0.7–1 mm, inconspicuous, covered by the pericarp, brown, hidden by the floral envelopes. Spore mass semiagglutinated, light brown, composed of spores intermixed with sterile cells. Spores (Figs. 20, 21) subglobose to broadly ellipsoidal, 17.5–21 x 18.5–23 µm, light yellow to pale yellowish-brown; wall very irregularly to incompletely reticulate, (5–)6–8 meshes per spore diameter, muri 1.5–3 µm high, in optical median view pointed. Sterile cells smaller than the spores (10–13 µm long), ovoid or slightly irregular, hyaline, wall 1–2.5 µm thick, smooth, content with a few granules.

The spore surface characters of *T. polypogonis* resemble those of *T. cerebrina* Ellis & Everhart but the spores of the latter species are much darker and larger (28–37 µm long) and the sterile cells are also larger (14–24 µm in diameter).

Light yellow to pale yellowish-brown spores are typical for T. lolii Auersw. ex Winter. However, the spores of this species are more regularly reticulated, the muri seen in optical median view are blunt and the sterile cells larger (13–19 µm long) than those in T. polypogonis.



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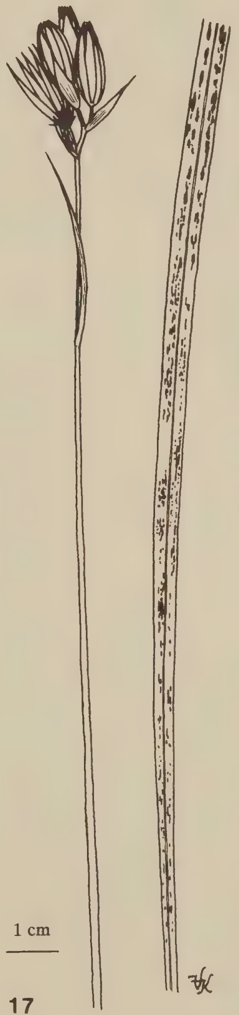

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Fig. 16. Sori of Tilletia polypogonis in the seeds of Polypogon monspeliensis (type).
Fig. 17. Sori of Urocystis camassiae in a leaf of Camassia quamash (type).

Urocystis camassiae K. Vánky, **sp. nov.**

Typus in matrice *Camassia quamash* (Pursh) E. L. Greene (Liliaceae), Canada, British Columbia, Vancouver Island, Victoria, Oak Bay, leg. J. A. Calder, J. A. Parmelee et R. L. Taylor. Holotypus in Herbario Ustil. Vánky (HUV 2642); isotypi in DAOM (83104) et BPI (181930). Paratypus on *Camassia hyacintha* (Rof.) Britt., USA, Indiana, Lafayette, 30.V.1907, leg. F. Vasku (BPI 182030!).

Sori (Fig. 17) in foliis et caulibus pustulae fusiformes vel pustuliformes 0,5–3 mm longae vel propter fusiones majores, primo lividi, epidermide tecti, serius epidermide rupto massa sporarum conglutinatarum nigrobrunnea, pulverea apparens. Sporae conglutinatae (Figg. 21, 22) subglobosae, ovoideae usque elongatae vel parum irregulares, 20–32 x 20–40(–55) µm, rufobrunneae, e sporis 1–5(–6) et e strato completo cellularum sterilium eas circumdato compositae. Sporae subglobosae, ovoideae, vel in lateribus contactus complanatae, (10–)11–15 x (12–)13–18,5 µm, rufobrunneae; pariete levi, 0,5–1 µm crasso. Cellulae steriles forma magnitudineque variae, 5–17 µm longae, flavidobrunneae, in senectute vulgo collapsae, pariete levi, 1–2(–3) µm crasso.

Sori (Fig. 17) in leaves and stems as fusiform or blister-like pustules of 0.5–3 mm length, or greater by fusion, at first lead coloured, covered by the epidermis, later the epidermis ruptures disclosing the blackish-brown, powdery mass of spore balls. Spore balls (Figs. 21, 22) subglobose, ovoid to elongated or slightly irregular, 20–32 x 20–40(–55) µm, reddish-brown, composed of 1–5(–6) spores completely surrounded by a layer of sterile cells. Spores subglobose, ovoid or flattened on contact sides, (10–)11–15 x (12–)13–18.5 µm, reddish-brown; wall 0.5–1 µm thick, smooth. Sterile cells variable in form and size, 5–17 µm long, yellowish-brown, usually collapsed in old specimens, wall 1–2(–3) µm thick, smooth.

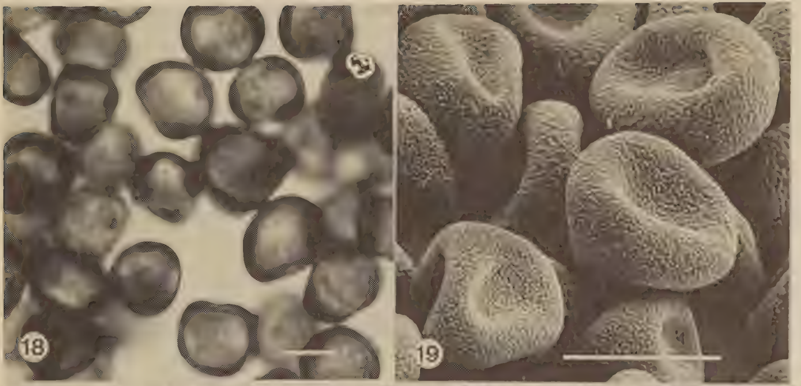
Typical distribution of spore number per spore ball in *Urocystis camassiae*: 1=45.5%, 2=34%, 3=13%, 4=5%, 5=2%, 6=0.5%, while *U. colchici* (Schlechtendal) Rabenhorst (type on *Colchicum autumnale* L.) has a higher proportion of few-spored spore balls: 1=73.5%, 2=22%, 3=4%, 4=0.5%.

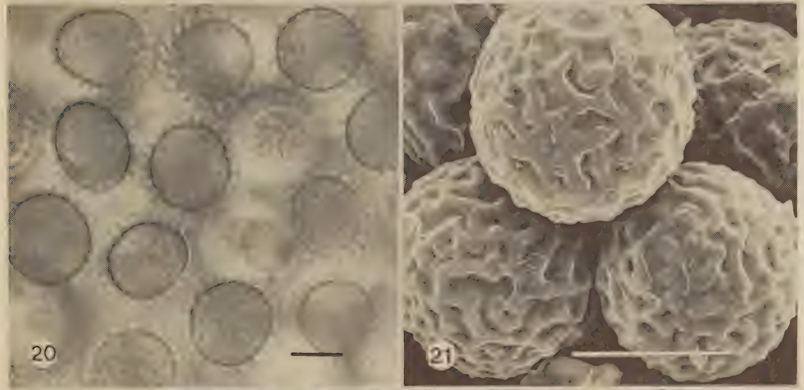
NEW COMBINATIONS PROPOSED

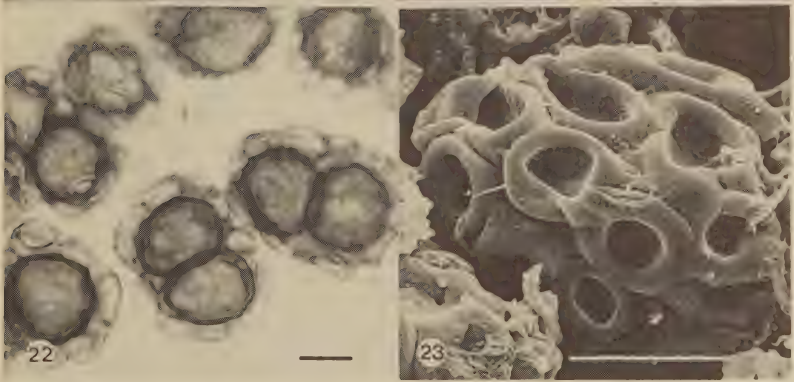
Thecaphora amaranthi (Hirschhorn) K. Vánky, **comb. nov.**

Basionym: *Glomosporium amaranthi* Hirschhorn, Mycologia 37:280, 1945. – Type on *Amaranthus* sp., Argentina, Salta, Oran, coll. Hunziker (2309).

The genus *Glomosporium* was described by Kochman (1939:58) to accomodate *Tolyposporium leptideum* H. Sydow. Typical for *Glomosporium* is the peculiar, *Tilletia*-type of germination resulting in aseptate basidia with 3–4 terminal, ovoid, subarcuate basidiospores each with two long "spinules" on their opposite ends. By analogy of the spore balls, without knowing the spore germination, Hirschhorn designated her new species to *Glomosporium*. Later Hirschhorn (1950) successfully germinated *G. amaranthi*. From the schematic drawings of Hirschhorn (1950:93), it appears that short or long aseptate basidia bear apically either several branches of hyphae, or 3–4 ellipsoidal basidiospores. Sporidia or hyphae then arise from distal parts of basidiospores. Ciferri (1963:142) interpreted this germination as longitudinal splitting of the branched promycelium (= basidium) resulting in two secondary branches. On the basis of this supposed longitudinal splitting of the basidia, which Ciferri compared to the basidia of Tremellales, Ciferri (1963:141) proposed the new family of Glomosporiaceae. In Ecuador recently collected *Glomosporium amaranthi* in the seeds of *Amaranthus hybridus* L. germinated on water-agar, after 1 day at room temperature. Germination (Fig. 24) resulted in long, 3–7-septate basidia bearing lateral and terminal ovoid or cylindrical basidiospores. Basidia may also develop shorter or longer lateral branches on which ovoid or cylindrical basidiospores are born. Because of this *Ustilago* type of germination the *Amaranthus* smut does not belong to *Glomosporium* and it is transferred into *Thecaphora*.







Figs. 18, 19. Spores of *Anthracoidea altiphila* in LM and SEM (holotype).
Figs. 20, 21. Spores of *Tilletia polypogonis* in LM and SEM (type).
Figs. 22, 23. Spore balls of *Urocystis camassiae* in LM and SEM. In the SEM picture the sterile cells are collapsed (type). bars = 10 μm

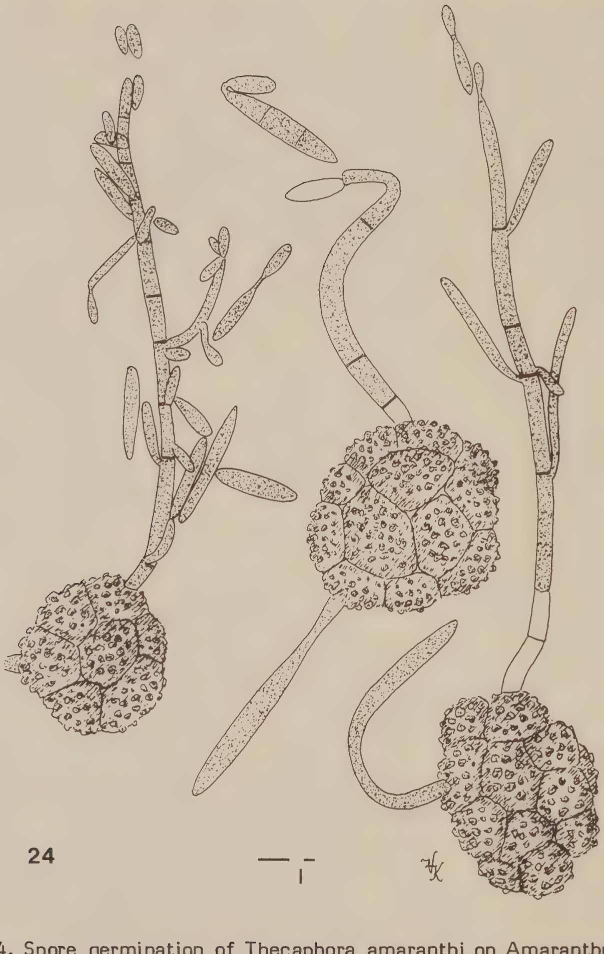


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Fig. 24. Spore germination of Thecaphora amaranthi on Amaranthus hybridus (Ecuador, Prov. Quito, between villages Pifo and Tunbaco, alt. 2550 m, 25.III.1991, C. Menge & K. Vánky; HUV 15881; bar = 10 µm).

Under unfavourable conditions the germination of different smut fungi may be altered. However, spores germinated under optimal conditions usually can be attributed either to the "Ustilago type", with septate basidia, or to the "Tilletia type" of germination, with aseptate basidia. Within both germination types exists, of course, a great variability. Schroeteria, with "intermediate type" of germination, turned out to be an ascomycete (Nagler & al., 1989). The "Glomosporiaceae type" of germination of Ciferri (1963) is a misinterpretation of schematically illustrated spores of Thecaphora amaranthi which were probably not germinated under optimal conditions.

Ustilago microstegii (S. Ahmad) K. Vánky, **comb. nov.**
Basionym Sphacelotheca microstegii S. Ahmad, Mycological Papers 64:6, 1956 (as microstegiae). – Type on Microstegium nudum (Trin.) A. Camus (Gramineae), West Pakistan, Murree, VIII.1952 (IMI).

Recently, I collected this fungus on both Microstegium nudum (India, U. P., Garwal Himalaya Mts., 12 km S. Gaurikund, alt. 1650 m, 15.IX.1992) and M. ciliatum (Trin.) A. Camus (Nepal, Kathmandu, Botanical Garden, alt. 1500 m, 3.V.1993). It is characterized by:

Sori culmicolous, comprising the floral stem and the entire inflorescence, flagelliform or with short branches, up to 10 cm long, when young covered by a thin membrane which flakes away disclosing the dark brown, powdery spore mass mixed with short chains of sterile cells. Finally, only the naked floral stem and branches remain behind. Spores globose, subglobose to ellipsoidal, 3.5–5 x 4–5.5 µm, olivaceous brown, in LM smooth, in SEM very finely verruculose. Sterile cells variable in shape and size, subglobose to subcylindrical or irregular, 4–9 x 5–12 µm, hyaline, thin-walled, smooth with homogeneous content. Spore germination (on water agar, after 2 days, at room temperature) results in short, conical basidium (1.5 x 1.5–3 µm) giving rise apically, successively several, cylindrical basidiospores of 1.5–2.5 x 6.5–11 µm, or 1–2, shorter or longer hyphae bearing lateral or terminal, subcylindrical basidiospores on short sterigmata. Basidiospores may fuse by copulation bridges giving rise to hyphae. Without copulation basidiospores may produce secundary sporidia or hyphae.

The genus Sphacelotheca is restricted to smuts on Polygonaceae. Typical are the ovaricolous sori covered by a peridium of host and fungal origin, and a columella of fungal cells. Spores, which develop from hyphae at the base of the sorus, are catenulate when young, connected by disjunctors, later single, not mixed with sterile cells.

The presence of sterile cells is typical for Sporisorium species but other characters of the Microstegium smut do not fit into this genus. Sterile cells are not typical for Ustilago species. Their origin and taxonomical significance in some Ustilago species (e. g. U. bursa, U. scitaminea, U. spermophora) is not clear. The Microstegium smut stands closest to the Ustilago hypodytes group differing from it by its spore germination and the presence of sterile cells.

ACKNOWLEDGEMENTS

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MYCOTAXON

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CONTRIBUTION TO THE LICHEN FLORA OF BRAZIL.XXX. ADDITIONAL RECORDS FROM THE MUNICIPALITY OF CANELA, RIO GRANDE DO SUL.

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ABSTRACT: Twenty-five lichens collected in Canela, Rio Grande do Sul, Brazil, are listed,including several new records.

During November 1992 the author gathered lichens in the Municipality of Canela which is located in the Rio Grande do Sul Highlands, Brazil. The collection sites are as follows:

(LP) The garden of the Laje de Pedra Hotel which is situated 2 km SE from Canela City (29°20'S-50°53'W).

(L) A small lake situated within the urbanized area which surrounds the Hotel.

In both places, for obvious reasons, only easy detachable species could be collected from native and cultivated trees. According to the literature consulted only three papers report lichens from this Municipality: Fleig 1990, Osorio & Arbelo Martins 1980 and Osorio & Fleig 1989.
This fact and the interest of some findings encouraged the author to publish the present list despite the small size of the collection.
An asterisk preceding a name indicates that this taxon has been reported already from the Municipality of Canela.
The numbers belong to the author's numbering system and the specimens are preserved in his private herbarium.
This paper is another contribution to the long-term plan towards a lichen flora of the Rio Grande do Sul Highlands.

Caloplaca crocea (Kremp.) Haf. & Poelt
   L: on broad-leaved tree, 9193 pr.p.
Caloplaca erythrantha (Tuck.) Zahlbr.
   L: on broad-leaved tree, 9193 pr.p.
Cetrariastrum cirrhatum (E. Fr.) W. Culb. & Ch. Culb.
   LP: on *Araucaria angustifolia*, 9211.
Cladonia ahtii Stenroos
   LP: on roots of *Araucaria angustifolia*, 9221.
Cladonia ceratophylla (Sw.) Spreng.
   LP: on broad-leaved tree, 9220.
Cladonia macilenta Hoffm.
   LP: on roots of *Araucaria angustifolia*, 9222.
Coccocarpia erythroxyli (Spreng.) Krog & Swinsc.
   LP: on *Lonchocarpus*, 9216.

Chiodecton sphaerale Ach.
LP: on *Araucaria angustifolia*, 9212. Formerly known in the State of Rio Grande do Sul only from Hamburgerberg in the Central Lowlands (Thor 1990:59).

(*) *Dictyonema glabratum* (Spreng.) D.Hawks.
LP:on *Araucaria angustifolia*, 9203, 9206.

(*) *Lobaria pseudoglaberrima* Zahlbr.
LP: on *Cupania vernalis*, 9204, on broad-leaved tree, 9210.

(*) *Megalospora sulphurata* Mey. & Flot. var.*nigricans* (Müll.Arg.) Riddle
LP: on broad-leaved tree, 9215.

Parmotrema crinitum (Ach.) Choisy
LP: on *Araucaria angustifolia*, 9218.

Parmotrema ultralucens (Krog) Hale
L: on broad-leaved tree, 9196. First record from the State of Rio Grande do Sul.

Pertusaria pulchella Malme
LP: on broad-leaved tree, 9199.

(*) *Pertusaria superans* Müll. Arg.
L: on broad-leaved tree, 9194.

Phaeographina lecanographa (Nyl.) Müll. Arg.
LP: on roots of broad-leaved tree, 9198.

(*) *Pseudocyphellaria aurata* (Ach.) Vain.
LP: on broad-leaved tree, 9209 pr.p.

Ramalina celastri (Spreng.) Krog & Swinsc.
L: on *Pinus*, 9195

Ramalina sprengelii Krog & Swinsc.
LP: on *Araucaria angustifolia*, 9202. In the State of Rio Grande do Sul this species was recently reported from the Municipality of Santa Maria in the Central Lowlands (Kashiwadani & Kalb 1993: 28).

Sticta fuliginosa (Dicks.) Arn.
LP: on broad-leaved tree, 9214.

Sticta sinuosa Pers.
LP: on broad-leaved tree, 9217.

Sticta weigelii (Isert) Ach.
L: on broad-leaved tree, 9197.

(*) *Teloschistes exilis* (Michx.) Vain.
LP: on broad-leaved tree, 9209 pr.p.

(*) *Teloschistes flavicans* (Sw.) Norm.
LP: on *Araucaria angustifolia*, 9219.

(*) *Usnea rubicunda* Sirt.
LP: on *Araucaria angustifolia*, 9207.

CONCLUSIONS

The results fo the study of this collections can be summarized as follow:

a) *Parmotrema ultralucens* is added to the known State flora.
b) *Chiodecton sphaerale* and *Ramalina sprengelii* are reported from the Rio Grande do Sul Highlands for the first time.
c) Seventeen species are added to the known lichen flora of the Municipality of Canela.

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MYCOTAXON

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AMANITA NOVINUPTA—A RUBESCENT, WHITE SPECIES FROM THE WESTERN UNITED STATES AND SOUTHWESTERN CANADA

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Summary

An agaric incorrectly referred to *Amanita rubescens* or *Amanita rubescens* var. *alba* in recent literature is new to science. The name *Amanita novinupta* is proposed.

In recent years, a rubescent *Amanita* associated with *Quercus* in the Pacific coastal states has been referred to *Amanita rubescens* Pers. var. *rubescens* or *A. rubescens* var. *alba* Coker. In fact, it is new to science.

Methods and terminology follow those of Tulloss *et al.* (1992) and Tulloss (1993). All anatomical studies were performed on exsiccata. Spores were measured in lateral view. Color codes of the form "6D6" are from (Kornerup & Wanscher, 1978). Color names in italic type and with first letters capitalized (*e.g.*, *Salmon-Buff*) are those of Ridgway (1912). With three exceptions, abbreviations for the names of herbaria follow Holmgren *et al.* (1990). The exceptions are

JEL - personal herbarium of J. E. Lindgren
KSB - personal herbarium of Kit Scates Barnhart, Post Falls, Idaho
RET - personal herbarium of R. E. Tulloss

Amanita novinupta (Fig. 1) is assignable to *Amanita* subgenus *Lepidella* (E. J. Gilb.) Ves. *emend.* Corner & Bas section *Validae* (Fr.) Quél. It is a medium-sized mushroom that is, at first, entirely white. The pileus soon develops pinkish tints that progress through various shades of pinkish brown or pale wine to reddish brown in age. All parts of the basidiocarp respond to bruising by turning pink to wine to red-brown. The stipe is annulate and has a basal bulb, which may not be very pronounced at maturity. Universal veil material on the pileus of young specimens is sometimes floccose-felted and not separated into distinct warts. At maturity, the universal veil may be absent from the pileus or found there as warts. At the stipe base, the universal veil is often distributed in rings somewhat reminiscent of the structure seen in *Amanita muscaria* (L.:Fr.) Pers., but also may be more evenly distributed in patches that may be overlooked or lost during collecting. The spore size and shape and the anatomy of the present species have more in common with European *Amanita rubescens* than with other entities described under that name from North America. The limits of known distri-

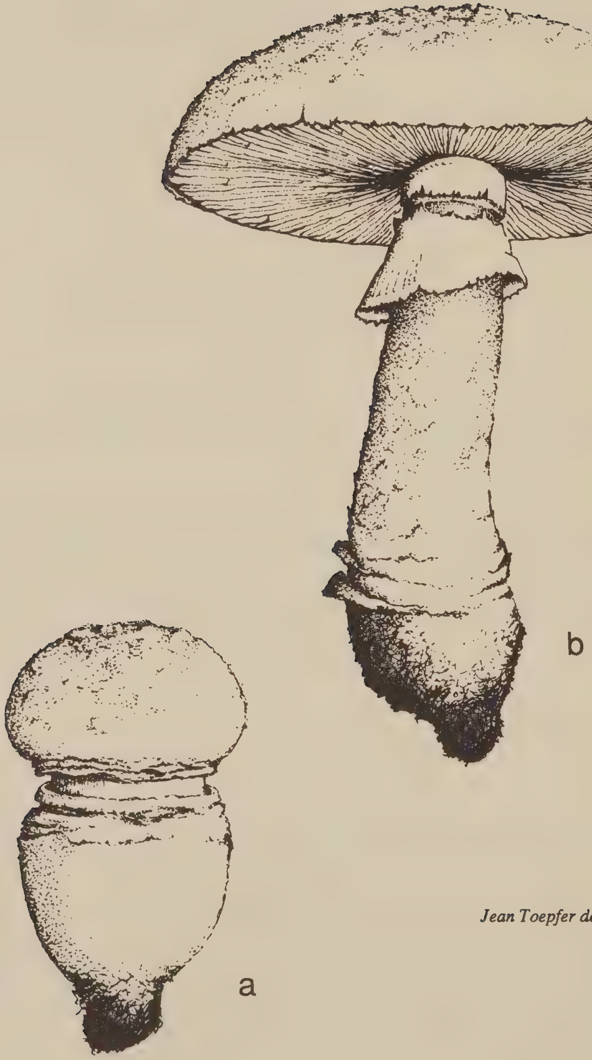

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Fig. 1 *Amanita novinupta* (Lindgren 93-06) habit (**a** x0.9; **b** x0.85).

bution are southwestern British Columbia and northern Idaho to the north and southern California, southern Arizona, and New Mexico to the south.

Amanita novinupta Tulloss & Lindgren *sp. nov.*

=*Amanita rubescens sensu* Thiers. 1982. *Agaricales*: 37, pl. 37A.
Illus.: Arora. 1979. *Demystified*: 226, 240.
Illus.: Orr & Orr. 1979. *Mushrooms*: pl. 66.
Illus.: Arora. 1986. *Demystified*, 2nd ed.: 264, 266, 276.
Illus.: Jenkins. 1986. *Amanita*: 184, Fig. 91.
Illus.: Arora. 1991. *Rain Promises*: 75.

Etymology: *novus*, new + *nupta*, bride; hence, a new bride because of the originally white coloration, the presence of white (universal and partial) veils, and a tendency to blush.

Pileus (10-) 31 - 110 (-150) mm *latus, initio albus deinde subroseus deinde roseo-alutaceus tum rubro-brunneus, carne alba rubescenti, margine decurvata non striata aliquando exigue appendiculata, velo universali initio albo deinde rubescenti tum brunneo et fragmenta subgossypina vel verrucae formans. Lamellae liberae vel subliberae approximatae vel confertae initio albae vel subalbae rubescentes ubi vulneratae; lamellulae truncatae vel subtruncatae vel attenuatae abundantes. Stipes* 20 - 150 (-180) x 10 - 32 (-51) mm, *initio albus deinde rubescens, carne alba rubescenti, velo hymeniali apicali vel subapicali membranaceo persistenti, bulbo ellipsoideo vel napiformi vel radicato aliquando non fere distinguibili ubi veto, velo universali saepe circa apicem bulborum cingulos formans vel indistincto vel in substrato remanens. Sporae* (6.2-) 8.2 - 10.8 (-14.8) x (4.2-) 5.5 - 7.2 (-8.8) µm. *Fibulae praesentes. Holotypus:* UNITED STATES OF AMERICA, Oregon, Washington County, Beaverton, Tektronix Campus, 14.iv.1992 J. E. Lindgren *s.n.* [Tulloss 4-14-92-JEL1] (NY).

PILEUS: (10-) 31 - 110 (-150) mm wide, white at first, then white with a pink tint that at times seems to be located below the surface, then ivory to light tan or white with a faint tan or light tan disk, often with a pink blush (*e.g.*, paler than *Salmon-Buff*), staining pale pinkish brown or *Buff-Pink* or *Testaceous* or *Terra Cotta* (8B5-6) or pale wine (*e.g.*, 9B-C4-5), finally red brown (*e.g.*, 9E6-7), occasionally flecked with gray in age, hemispheric at first, then convex to planoconvex to planar, occasionally (at any stage) with depressed disk, dry, at first with a chalky or pulverulent appearance, later dull to shiny or satiny in older specimens; *context* white (''chalk white''), bruising slowly red-brown to red to wine or (despite marked color changes in both pileipellis and stipe context) scarcely becoming pink or not changing, 4 - 14 mm thick at stipe, thinning evenly to margin, occasionally with a hollow spot under the pileipellis in disk; *margin* inflexed at first, later decurved, nonstriate, occasionally appendiculate with small white crumbs or submembranous flakes or with shreds of the partial veil (*e.g.*, a very narrow, uneven, ring of material on the pileus margin of one of ten basidiocarps in holotype); *universal veil* as small subpyramidal warts or as nearly confluent and rather thick patches, floccose-felted (soft and cottony) when fresh, with fibrillose to striate-eroded sides after exposure *in situ*, becoming fine scales toward margin in age, white at first, then pale pinkish (9A2) or pale pinkish beige, becoming more pink on bruising, brown in age, detersile when young (but not easily rubbed off as in *A. smithiana* Bas or *A. silvicola* C. H. Kauffm.), becoming firmly attached in age, often leaving no mark when removed.

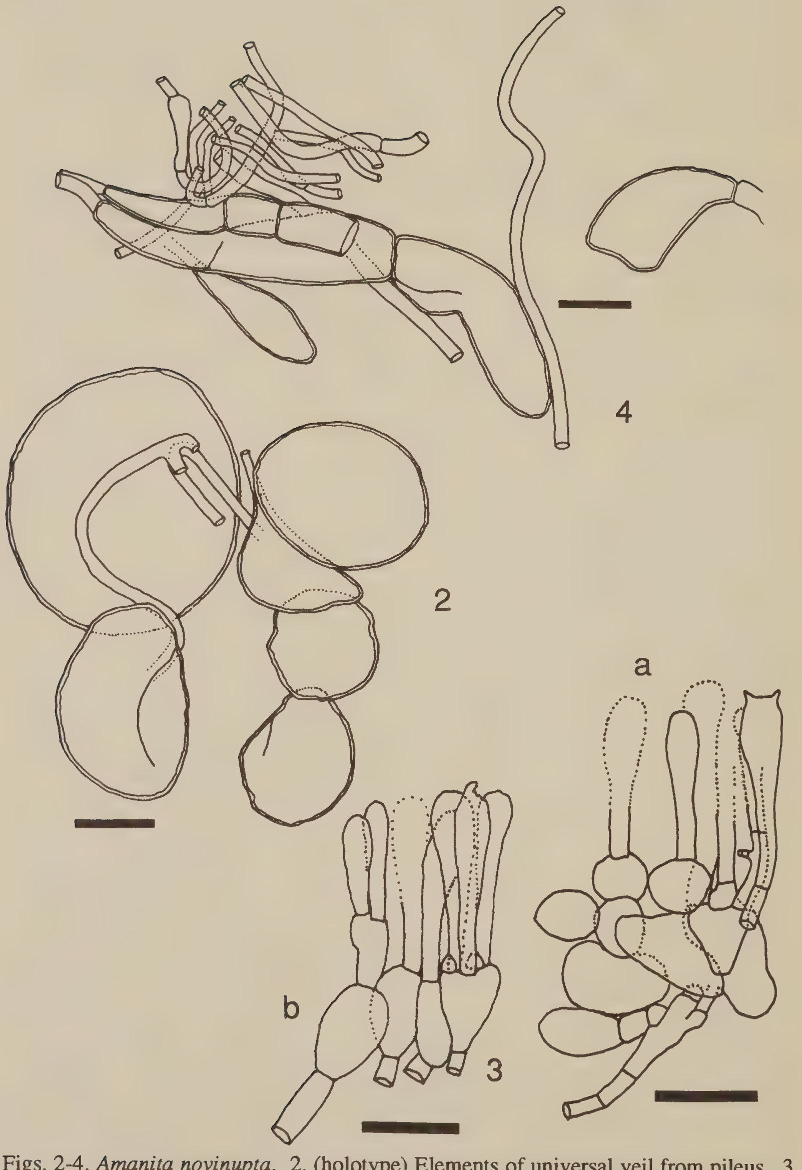
LAMELLAE: narrowly adnate to free, with short decurrent line on stipe apex, close to subcrowded to crowded, off-white to pale cream to pale grayish white in mass, more or less off-white to translucent white to pale sordid white to pale sordid cream in side view, becoming pinkish when bruised, 3 - 11 mm broad, broadest at a point three-quarters of radius from stipe, rarely forking; *lamellulae* (in order from shortest to longest) truncate to rounded truncate to subtruncate to rounded subtruncate to attenuate, of diverse lengths, plentiful.

STIPE: 20 - 150 (-180) x 10 - 32 (-51) mm, white, bruising/staining as on pileipellis, often pinkish to some degree when collected, narrowing upward, sometimes flaring at apex, surface with fibrillose-floccose to floccose to squamulose decoration, more or less longitudinally striatulate, often with recurved up-pointing scales, at times with circumscissile cracking near top of bulb; *bulb* 11 - 63 x 17 - 38 mm, ellipsoid to subnapiform to broadly napiform to napiform or rooting, often without a clear point of demarcation from the stipe at maturity, with upper portion often shrinking inward on drying so that stipe appears to arise in a depression in some exsiccata; *context* solid or stuffed, and then with 5 - 15 mm wide central cylinder, occasionally hollow in part, occasionally water-soaked, white to off-white, bruising as elsewhere in the basidiocarp or light to medium red-brown, with lower bulb occasionally showing no reaction or bruising a deeper brown than remainder of stipe context, insect tunnels white or bruising as elsewhere in the stipe or brick red (in bulb); *partial veil* membranous, skirt-like, persistent, white, sometimes with reddish tints, with pinkish tan or brownish particles or thickened warts at the edge, apical to superior, striate to faintly striate above, cottony fibrillose or floccose-felted below, collapsing on stipe in age; *universal veil* white, then staining as on pileus, at first often as a narrow and well-defined limb at the juncture of stipe and bulb, later as a few concentric rings of small warts (somewhat suggestive of *A. muscaria*) on lower stipe and upper part of bulb or as faint cottony material on lower stipe or not evident, almost always left in substrate (at least in part).

Odor faintly fungoid or ‘‘normal agaric’’ (McMurphy) or odorless (holotype) or mild (Halling 7094). *Taste* ‘‘normal agaric’’ (McMurphy).

MACROCHEMICAL TESTS: Spot test for laccase (syringaldazine) - negative throughout basidiocarp. Spot test for tyrosinase (paracresol) - in mature material, positive in lamellae, stipe (above bulb), throughout context of disk, and on surface of warts on pileus; in a specimen with the partial veil still covering the lamellae, negative or weakly positive in stipe interior (5 min.), then positive under pileus cuticle, in partial veil tissue and more strongly in stipe interior (10 min.); in a specimen in which sporulation had just recently begun, positive in pileipellis and universal veil on pileus, throughout the bulb, in a piece of *limbus internus* material on the underside of the margin of the partial veil, and in isolated spots on lamella surfaces and in upper stipe. 95% ethanol - negative throughout basidiocarp. $FeSO_4$ - red-brown larva tunnels turn dark gray to almost black; otherwise, negative throughout basidiocarp. Dilute H_2SO_4 - negative throughout basidiocarp. 10% KOH - negative after 5 min. throughout basidiocarp. NH_4OH - negative throughout basidiocarp after 5 min. Phenol - in mature specimen, purple-gray after 12 min. with distribution of color reaction in tissue as for paracresol. Voucher specimens tested: Tulloss 2-25-89-B, Tulloss 3-2-89-I, Lindgren 91-9, Lindgren 92-7, and Lindgren 93-06. Results according to Breckon (1968)—on exposed context of the lower stipe and bulb: $FeSO_4$ - yellowish at first, then fading; 3% KOH - negative; Melzer's reagent - negative; phenol - negative; phenolaniline - negative; tincture of guaiac - very slowly positive.

PILEIPELLIS: orangish yellow in 3% KOH, completely gelatinized at surface, extensively gelatinized below, 160 - 170 μm thick over disc; filamentous, undifferentiated hyphae 2.0 - 8.2 μm wide, branching, densely interwoven, with ungelatinized elements criss-crossed when viewed from above; vascular hyphae (observable in scalp) 3.5 - 20.5 μm wide, rather common both at and below surface, sinuous, with lumpy outline, branching occasionally. PILEUS CONTEXT: filamentous, undifferentiated hyphae 1.7 - 7.0 μm wide, branching, plentiful, thin-walled, often in fascicles (loosely interwoven with other fascicles and solitary hyphae); acrophysalides plentiful, thin-walled, clavate to broadly clavate to narrowly ellipsoid to subfusiform, up to 146 x 58 μm; vascular hyphae not observed. LAMELLA TRAMA: bilateral; central stratum dominantly a tangle of hyphae, with w_{cs} = 50 - 65 μm (40 - 45 μm with sporulation just beginning), with divergence at a shallow angle, usually under 30°, with elements of subhymenial base reaching an angle of 45° or 90° to the central stratum before reaching the smaller cells of the subhymenium, with larger inflated cells of subhymenial base clavate to ovoid to ellipsoid to irregular (*e.g.*, 22 x 14.5 μm); filamentous, undifferentiated hyphae 1.8 - 8.0 μm wide, densely interwoven, frequently branching, with occasional segments slightly inflated; divergent, terminal, inflated cells infrequent and identical in form to long partially inflated cells of subhymenial base (*e.g.*, narrowly clavate, 83 x 17.2 μm); vascular hyphae 1.0 - 6.5 μm wide, branching, not observed in most sections, tangled and plentiful locally when seen; clamps present. SUBHYMENIUM: w_{st}-near = 25 - 55 μm; w_{st}-far = 35 - 70 μm; a branching structure composed of an irregular mixture of inflated and partially inflated cells and short hyphal segments, giving the impression of being pseudoparenchymatous, with 3 to 5 inflated cells between central stratum and bases of longer basidia/-oles, with elements just below basidia usually having major axis perpendicular to central stratum, with basidia arising from elements of all types, with one to two cells between bases of longest and shortest basidia/-oles in a given region; clamps scattered, infrequent. BASIDIA: 34 - 49 (-67) x 8.5 - 12.5 (-21) μm, thin-walled, 4- or (occasionally) 2-sterigmate; clamps and proliferated clamps scattered to (rarely) relatively common locally, sometimes rather small. UNIVERSAL VEIL: *On pileus*: with individual cells widely distributed over surface outside of warts or patches (even in mature material with completely gelatinized pileipellis surface); filamentous, undifferentiated hyphae 2.5 - 10.0 μm wide, branching, common, a few with slightly thickened yellow subrefractive walls, but dominantly hyaline, with walls up to 0.8 μm thick; inflated cells dominating, terminal, singly or in short chains, hyaline or (occasionally) pale brown (in Halling 7094), globose to subglobose to subpyriform to pyriform to clavate to ovoid to broadly ellipsoid to ellipsoid, up to 103 x 77 μm, with majority having major diameter less than 75 μm, often dissociated, with walls thin or up to 1.0 μm thick; vascular hyphae not observed. *On stipe base*: similar to that on pileus except having a significantly larger proportion of filamentous, undifferentiated hyphae. STIPE CONTEXT: longitudinally acrophysalidic; filamentous, undifferentiated hyphae 2.0 - 11.2 μm wide, branching, common to plentiful, with walls thin or slightly



Figs. 2-4. *Amanita novinupta.* 2. (holotype) Elements of universal veil from pileus. 3. Elements of hymenium and subhymenium and adjacent central stratum: **a** holotype, **b**. 29.vii.1993 Barnhart *s.n.* 4. (holotype) Elements of partial veil. Dark bars indicate 20 µm. Thickness of cell walls not to scale.

thickened, often constricted at septa; acrophysalides dominating, up to 310 x 49 μm, with walls thin or up to 0.8 μm thick; vascular hyphae not observed; clamps not observed. PARTIAL VEIL: filamentous, undifferentiated hyphae 1.0 - 11.9 μm wide, extensively branching, dominating, often coiling and twisting, tending to form radially oriented fascicles, although often not in fascicles, very occasionally with yellow wall, with walls thin or less than 0.5 μm thick, with thicker walled hyphae having occasional partially inflated intercalary segments (up to 15.5 μm wide); inflated cells throughout tissue, elongate to clavate to subfusiform to cylindric, up to 114 x 25 μm, terminal, singly or in short chains, common, locally plentiful, with walls thin or up to 0.5 μm thick; vascular hyphae 4.9 - 12.8 μm wide, branching, scattered to locally plentiful.

BASIDIOSPORES: [1457/72/41] (6.2-) 8.2 - 10.8 (-14.8) x (4.2-) 5.5 - 7.2 (-8.8) μm, (**L** = (8.1-) 8.6 - 10.2 (-11.0) μm; **L'** = 9.4 μm; **W** = (5.5-) 6.0 - 6.8 (-7.2) μm; **W'** = 6.3 μm; Q = (1.13-) 1.31 - 1.69 (-2.47); **Q** = (1.34-) 1.39 - 1.58 (-1.72); **Q'** = 1.48), hyaline, thin-walled, smooth, amyloid, ellipsoid, occasionally broadly ellipsoid, occasionally elongate, rarely cylindric, very rarely subglobose, adaxially flattened, occasionally expanded at one end; apiculus sublateral, cylindric; contents mono- or multiguttulate to granular; white in deposit.

Distribution and habitat: Solitary to scattered to gregarious in troops. British Columbia: under conifers in lawn. Arizona: under *Pseudotsuga menziesii* (Mirb.) Franco and *Pinus ponderosa* Dougl. *ex* Laws. at 2450 m elev. Amador, San Mateo, and Santa Cruz Cos., Calif.: under *Quercus*, including *Q. agrifolia* Née. Mendocino and Nevada Cos., Calif.: in mixed forest. Pt. Reyes National Seashore and Idaho sites: with *P. menziesii*. New Mexico site: in forest of *Abies*, *P. menziesii*, *Picea*, and *P. ponderosa*, at 2700 m elev. Beaverton, Oregon, site (type locality): in lawn and in heavily mulched landscaped area and adjacent lawn, under mature *Q. garryana* Dougl. *ex* Hook., with clay and loam or silt (prior to landscaping the area was low and wet with nearby streams), with a tan *Amanita* otherwise similar to *Amanita muscaria* occurring in the same site in autumn. Lake Oswego and Tigard, Oregon, sites: in landscaped area under *Quercus*, (*e.g.*, *Q. garryana*). Fern Ridge Reservoir, Lane Co., Oregon: under *Quercus kelloggii* Newb., which reaches the northern limit of its distribution in Lane Co. (Hitchcock and Cronquist, 1981).

Collections examined: **CANADA:** BRITISH COLUMBIA—West Vancouver, 16.x.1983 Avoca Mielke *s.n.* [Paul Kroeger PK710] (UBC as "*Amanita rubescens*"). **UNITED STATES OF AMERICA:** ARIZONA—Pima Co. - Loma Linda, Santa Catalina Mtns., 29.viii.1992 Susan B. Fleming 5 (RET). CALIFORNIA—Amador Co. - Ione, 14.iv.1967 Harry D. Thiers 18724 (SFSU as "*Amanita rubescens*"); *ca.* Ione, 13.iv.1965 H. D. Thiers 12349 (SFSU as "*Amanita rubescens*"). Humboldt Co. - Eureka, 30.xi.1933 P. C. Richardson *s.n.* [Fungi of Pacific States 287] (BPI as "*Amanita silvicola*"). Marin Co. - Pt. Reyes Nat. Seashore, Limantour Ridge, 2.ix.1981 Dennis E. Desjardin 328 (SFSU as "*Amanita rubescens*"). Mendocino Co. - *ca.* Mendocino, Jackson St. For., 23.xi.1962 H. D. Thiers 9459 (SFSU as "*Amanita rubescens*"), 5.i.1963 H. D. Thiers 9957 (SFSU as "*Amanita rubescens*"), 10.xi.1963 H. D. Thiers 10634 (SFSU as "*Amanita rubescens*"), 17.xi.1963 H. D. Thiers 10724 (SFSU as "*Amanita rubescens*"). Nevada Co. - *ca.* Nevada City, Hwy. 49, 8.vi.1964 H. D. Thiers 11220 (SFSU as "*Amanita rubescens*"). Orange Co. - Mission Viejo

Ranch, 25.ii.1989 C. W. Hendel *s.n.* [Tulloss 2-25-89-B] (L; RET). Santa Cruz Co. - Aptos Hills S of Aptos, John Feci & R. E. Tulloss 3-2-89-F (RET), -G (L; RET); Watsonville, J. Feci & R. E. Tulloss 3-2-89-I (RET). San Mateo Co. - Huddart Pk., 11.xi.1962 Walter J. Sundberg 32 (SFSU as "*Amanita rubescens*"); San Bruno, Junipero Serra Pk., 1.ii.1961 H. D. Thiers 8699 (SFSU as "*Amanita rubescens*"), 7.iv.1961 S. Sisk *s.n.* (SFSU as "*Amanita rubescens*"); San Bruno St. Pk., iv.1966 Gary J. Breckon 311 (SFSU as "*Amanita rubescens*"); San Francisco Watershed, 2.xii.1962 Esther Whited *s.n.* (SFSU as "*Amanita rubescens*"), 22.ii.1965 H. D. Thiers 12201 (SFSU as "*Amanita rubescens*"), 16.iv.1966 H. D. Thiers *s.n.* [G. J. Breckon 358] (SFSU as "*Amanita rubescens*"). *Ca.* border San Mateo & Santa Clara Cos. - *ca.* Stanford Univ., Jasper Ridge, 21.iii.1916 J. McMurphy 209 & 210 (BPI as "*Venenarius solitarius*" & "*Amanita solitaria*" respectively); *ca.* Stanford Univ., Searsville Lake, 7.i.1916 J. McMurphy 197 (BPI as "*Venenarius solitarius*"). IDAHO——Kootenai Co. - E side of Coeur d'Alene Flats, 29.vii.1993 Kit Scates Barnhart *s.n.* (KSB; RET). NEW MEXICO——Taos Co. - W of Red River, Hwy. 38 btwn. Elephant Rock Campground & Molybdenum mine, 4.ix.1993 Roy E. Halling 7094 (NY). OREGON——Clackamas Co. - Kruse Way btwn. Tigard & Lake Oswego, 6.v.1990 Kathy & Paul Patrick *s.n.* [Lindgren 906] (RET); Lake Oswego, 24.iv.1992 P. & K. Patrick *s.n.* [Lindgren 92-14] (RET). Coos Co. - Tams Rd., 30.vi.1986 Catherine Ardrey 973 (WTU as "*Amanita rubescens*"), 19.ix.1986 C. Ardrey 1032 (WTU as "*Amanita rubescens*"). Lane Co. - Richardson's Park, Fern Ridge Reservoir, 15.v.1991 Freeman Rowe *s.n.* [Lindgren 91-10] (RET). Washington Co. - Beaverton, Tektronix Campus, 23.iv.1990 Lisa Volpel *s.n.* [Lindgren 90-4] (JEL; RET; WTU as "*Amanita rubescens* var. *alba*"), 13.v.1991 J. E. Lindgren 91-9 (JEL; RET), 10.iv.1992 J. E. Lindgren 92-7 (RET), 14.iv.1992 J. E. Lindgren *s.n.* [Tulloss 4-14-92-JEL1] (holotype, NY; isotype, L; isotype, RET; isotype, WTU), 12.v.1992 J. E. Lindgren 92-19 (RET), 8.v.1993 J. E. Lindgren 93-06 (RET); Tigard, 28.iv.1988 Jim & Wanda Caruthers *s.n.* [Lindgren 115] (RET). WASHINGTON——Mason Co. - Olympic Nat. Pk., Staircase Campground, 2.ix.1971[?], F. Van de Bogart 778 (WTU as "*Amanita rubescens*"). Thurston Co. - *ca.* Olympia, Millersylvania St. Pk., *n.d.* collector unknown *s.n.* (WTU as "*Amanita rubescens*").

DISCUSSION

Initial absence of pigmentation, occasionally subfelted and cottony universal veil material on the pileus, and an occasionally scantily appendiculate pileus margin might suggest placement of *A. novinupta* in *Amanita* section *Lepidella*. However, the anatomical similarities to *A. rubescens* var. *rubescens* (see below), including plentiful inflated cells in the subhymenial tree (Tulloss, 1990: 131) are convincing reasons for placement of *A. novinupta* in *Amanita* section *Validae*.

Taxa with which the new species should be compared are *A. brunneolocularis* Tulloss *et al.* (1992), described from Colombia; *A. orsonii* Kumar & Lakhanpal *in* Kumar *et al.* (1990), described from northern India; *A. rubescens* var. *rubescens* (European material); and *A. rubescens* var. *alba* (Coker, 1917) from the eastern U.S.A. *Amanita novinupta* differs from all four in having an universal veil that sometimes appears as soft, cottony patches on the pileus. Moreover,

- *Amanita brunneolocularis* differs from *A. novinupta* in having
  - an originally pigmented pileipellis
  - relatively common, brown cells in the universal veil
  - cells in the universal veil that are less frequently in chains
  - spores that are somewhat shorter and proportionately broader [**L** = (8.3-) 8.4 - 9.4 µm; **W** = (6.1-) 6.3 - 7.0 µm; **Q** = 1.27 - 1.34 (-1.36)]
  - divergent, terminal, inflated cells in the lamella trama that often have thickened walls and measure up to 72 x 25 µm (Tulloss, unpub. data)
  - 3 to 4 cells between the central stratum and bases of longer basidia/-oles
  - smaller, rounder cells in the partial veil
  - no observed clamps.

- The spores of *A. orsonii* are smaller and rounder on average than those of *A. novinupta* (Tulloss, unpub. data): [93/4/2] (6.5-) 7.2 - 9.0 (-9.8) x (5.0-) 5.5 - 6.8 (-7.5) µm, (**L** = 7.7 - 8.8 µm; **L'** = 8.2 µm; **W** = 5.9 - 6.3 µm; **W'** = 6.2 µm; Q = (1.14-) 1.17 - 1.50 (-1.58); **Q** = 1.26 - 1.39; **Q'** = 1.34). Additionally, *A. orsonii* differs from *A. novinupta* by having
  - a subhymenium that is largely composed of branching hyphae with fewer inflated cells scattered in only two to three layers
  - elements below basidia not at 90° angle to central stratum (angles ranging roughly from 30° to 75°)
  - no observed clamps.

- The anatomy of *A. rubescens* var. *rubescens* (based on collections from northern Europe) was discussed briefly by Tulloss *et al.* (1992). Its spores are very close in size and shape to those of *A. novinupta* [**L** = 8.6 - 10.1 µm; **W** = 6.0 - 6.4 µm; **Q** = 1.38 - 1.58]. *Amanita rubescens* var. *rubescens* differs from *A. novinupta* by having
  - an originally pigmented pileus
  - no observed clamps [also noted by Bas (1969: 319-320)]
  - universal veil becoming gray in age
  - relatively common vascular hyphae in the universal veil
  - no thick-walled elements in universal veil
  - radially arranged hyphae of the partial veil not forming robust fascicles
  - sparsely distributed, divergent, terminal inflated cells in the lamella trama measuring up to 30 x 12.2 µm (Tulloss, unpub. data).

- *Amanita rubescens* var. *alba* differs from *A. novinupta* by having
  - a pileus that is broadly campanulate becoming planoconvex, frequently with distinct umbo
  - no squarely truncate lamellulae
  - smaller and proportionately broader spores: [141/7/6] (6.5-) 7.0 - 9.8 (-10.5) x (4.5-) 5.0 - 7.0 (-8.5) µm, (**L** = 7.6 - 9.0 (-9.2) µm; **L'** = 8.3 µm; **W** = 5.5 - 6.1 (-6.7) µm; **W'** = 5.9 µm; Q = (1.12-) 1.24 - 1.60 (-1.69); **Q** = 1.34 - 1.49 (-1.50); **Q'** = 1.41)
  - a partial veil that is sometimes yellow, most frequently on the under side
  - no observed clamps [as also reported by Jenkins (1986)]
  - shorter and proportionately broader inflated cells throughout partial veil.

Material of *A. orsonii* studied included an isotype (BPI 71991). Material of *A. rubescens* var. *alba* studied included both syntypes (Coker 2346, Coker 2355 in NCU) and Tulloss' numbers 8-12-81-B, 7-6-83-B, 8-24-85-A, and 7-19-86-B (all in RET).

The entity from eastern North America called *A. rubescens* has not been thoroughly studied to date, but it appears to be similar anatomically to *A. brunneolocularis* and *A. rubescens* var. *alba* and, consequently, distinct from the true *A. rubescens* of Europe and *A. novinupta* (Tulloss, unpub. data).

The very few divergent, terminal, inflated cells seen in the lamella trama of *A. novinupta* were concentrated in the half of the lamella closest to the pileus context.

One collection we examined had been determined previously as *A. silvicola*. The latter species of *Amanita* section *Lepidella* does not take on pinkish or reddish tones when bruised and has numerous microscopic characters differing from those in *A. novinupta* (Bas, 1969). In addition, Tulloss & Lindgren (1992) have reported that a paracresol spot test for tyrosinase was negative throughout the basidiocarp in tested collections of *A. silvicola*.

All collections cited by Breckon (1968) as ''*A. rubescens*'' were reviewed (excepting one consisting only of a ''button'' specimen) and were found to be *A. novinupta*. For this reason, we included Breckon's macrochemical test data.

The highest value of **L** for *A. novinupta* was computed for the single specimen of Thiers 9957, which was dried early in sporulation and (probably as a consequence) has many occasionally misshapen, ''giant'' spores on its lamellae. The specimen with the smallest value of **L** and the next-to-smallest value of **Q** was Tulloss 2-25-89-B. This specimen was collected during a very dry year and sat, as an expanding button, on a display table at a foray for the better part of a day before it could be dried. A variety of stresses and having been dried early in sporulation may have contributed to the unusually small spores.

The largest **Q** value and the smallest **W** value were computed for one of the specimens of Thiers 8699. This specimen was mature or past maturity (pileus concave), the spore lengths measured did not have a normal distribution and included the longest spore measured (also having the highest value of Q computed) as well as a deformed and subsinuate spore. The smallest **Q** value and the largest **W** value were computed for one of the poorly preserved specimens of the Whited (San Mateo Co.) collection. The hymenium of this specimen was poorly preserved, and the central stratum of the lamella trama rehydrated incompletely. However, the subhymenial tree conformed to the dimensions and structure of that in *A. novinupta*; and one clamp was observed in the hymenium. The specimen was determined as ''*A. rubescens*'' by Breckon.

L and **Q** values were generally skewed upward among the seven sporulating specimens of the holotype. **L** ranged from 9.3 µm to 10.2 µm with both average and median of 9.6 µm. **Q** ranged from 1.44 - 1.64 with an average of 1.51 and a median of 1.48. Since the skewing is slight and doesn't impact on the question of segregating the present species from others (above) and since the collection is a very rich one that is extremely well documented, we find no problem with picking it as the holotype.

Because *A. rubescens* as understood in eastern North American is the North American species most often reported as liable to attack by *Hypomyces hyalinus* (Schw.:Fr.) Tul. [*e.g.*, by Krieger (1936: 59) and Arora (1986: 884, fig.)], we sought evidence for or against *A. novinupta*'s being a host of *H. hyalinus*. Drs. C. T. Rogerson, NY, and G. J. Samuels, BPI, (pers. comm.) informed us that, in a study being prepared for publication, they describe the known range of *H. hyalinus* as overlapping that of *A. novinupta* in Idaho and Washington. Although the hosts are believed to belong in *Amanita*, no host species has been determined for collections from the cited states. Lindgren made a point of examining all material of *A. novinupta* she encountered for signs of hypomycization. No indication of *Hypomyces* was found.

The uniform pink blush that develops first in the pileus of fresh and unbruised material can be observed in nature or by refrigerating such material for 8 - 10 hours.

Biek (1984) reports "*A. rubescens*" from Shasta Co., Calif. and indicates that the species is characteristic of "Foothill Woodland" (characterized by presence of *Pinus sabiniana* Dougl., *Quercus douglasii* Hook. & Arn., *Q. wislizenii* A. DC., *Q. chrysolepis* Liebm., and *Q. lobata* Née) and is frequently associated with *Quercus* including *Q. wislizenii* and *Q. chrysolepis*.

Greg Wright, Claremont, California, (pers. comm.) reports this species from southern California where he says it occurs "with oak at low elevations in spring and less commonly winter, and occasionally with mixed oak & pine and uncommonly mixed pine & fir in the mountains from spring to fall, usually single." He distinguishes two entities with the habit and spore size of the present species. One gives a strong, immediate, gray-green response to $FeSO_4$; the other does not react with that reagent. He notes other differences of taste, odor, and macrochemical reactions. We are interested in receiving material similar to *A. novinupta* with a gray-green reaction to $FeSO_4$.

We have referred to *A. novinupta* in regional keys, checklists, and correspondence as "species AZ24", "species C10", "species C11", and "species NW3-WR".

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NOTES ON THE AMPHISPHAERIACEAE AND RELATED FAMILIES

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SUMMARY

The relationships of three families, Amphisphaeriaceae, Clypeosphaeriaceae, and Pleurotremaceae are considered, as are those of other members of the Xylariales in a narrow sense. Keys are provided to the families accepted in the order, to the genera assigned to three of the families, and to North American species of these genera. Newly described are one genus *Dyrithium*, and ten species: *Amphisphaerella deceptiva*, *Amphisphaeria arizonica*, *Crassoascus canadensis*, *Discostroma empetri*, *D. ledi*, *D. pachystimae*, *D. rhododendri*, *Phomatospora striatispora*, *P lithocarpi*, and *Saccardoella separans*. New combinations are proposed as: *Discostroma succineum*, *Dyrithium lividum*, *Jobellisia rhynchostoma*, *Phomatospora minutella*, *Pseudovalsaria peckii*, and *Saccardoella macroasca*.

The original intent of this article was to review the North American taxa assigned to the Amphisphaeriaceae and Clypeosphaeriaceae. As work progressed, certain problems were encountered, in particular the separation of families and the arrangement of genera. Eventually, it became necessary to recognize yet another family in the group of organisms involved. This contribution now considers the relationships and the differences among the taxa that I assign to three families of the Xylariales. Certain genera are shifted from the position given them earlier (Barr 1990a). Some other genera that Eriksson and Hawksworth (1991) arranged in the Amphisphaeriaceae are not known to me and are not mentioned here. Others belong elsewhere, i.e., *Ceriospora*, *Leiosphaerella*, *Oxydothis*, *Vialaea*, are more typical of the Hyponectriaceae, whereas *Diapleella* (= *Kalmusia*) is a loculoascomycete in the Phaeosphaeriaceae, Pleosporales (Barr 1992). Based on peridium and centrum structure, *Iodosphaeria* belongs in the Lasiosphaeriaceae, Sordariales. *Cainiella* is perhaps diaporthaceous, and *Ceratostomella*, again separated from *Endoxyla*, is also diaporthaceous, both genera forming part of a group of taxa that eventually must be recognized as separate from the families presently accepted in that order.

The taxa under consideration share a number of characteristics that are typically xylariaceous, and, with the Boliniaceae, Xylariaceae, and Diatrypaceae, they constitute the restricted order Xylariales. Ascomata may be hemibiotrophic, saprobic or hypersaprobic; they develop in leaves, herbaceous stems, monocot culms, periderm of woody branches, or old wood. They may be separate or gregarious, sphaeroid or globose to ovoid, with a papillate apex or a stout beak in which the ostiole is periphysate. The peridium is composed of few to numerous rows of compressed cells, often visible in surface view as *textura intricata*. Asci develop peripherally, are typically cylindric or clavate cylindric with a short to elongate stipe. The apical region bears a narrow or enlarged apical ring, amyloid or nonamyloid, sometimes surmounted by a refractive pulvillus. Paraphyses are apically free, narrow, septate, guttulate, often deliquescent at maturity. Variations in stromatic development are particularily noteworthy in members of the Boliniaceae, Diatrypaceae and Xylariaceae, whereas members of the other families generally form clypeal tissues over apices of ascomata, although a few taxa have valsoid ascomata beneath a stromatic disc. The characteristics that are basic for separation of members of the order into families are chiefly those of the ascospores.

Key to Families of Restricted Order Xylariales

1. Ascospores brown, typically with elongate germ slit, aseptate or one-septate near end with pallid, small end cell; asci typically cylindric, apical ring amyloid; ascomata in variously shaped and developed stromata or separate or grouped beneath clypeus............Xylariaceae
1. Ascospores brown or hyaline, lacking elongate germ slit, variable in septation............................2
    2. Ascospores allantoid, light to dark brown, lacking germ slit or germ pore, usually aseptate; asci clavate cylindric and stipitate, apical ring amyloid or nonamyloid; ascomata grouped in stromata in various configurations..................Diatrypaceae
    2. Ascospores not allantoid, aseptate or septate, hyaline or brown; ascomata immersed beneath clypeus or in stromata in various configurations...........3
3. Ascospores radially symmetric, hyaline or brown; asci typically cylindric, apical ring amyloid or nonamyloid...4
3. Ascospores radially asymmetric, shades of brown; asci cylindric or clavate cylindric and stipitate, apical ring nonamyloid or amyloid................................5

4. Ascospores hyaline, distoseptate or containing large globules, lacking germ pores; ascus ring nonamyloid; ascomata immersed singly beneath closely adhering clypeus....................Pleurotremaceae

4. Ascospores brown or hyaline, if distoseptate then brown, at times with one or more germ pores when brown; ascus ring amyloid or nonamyloid; ascomata immersed singly or few beneath clypeus or in valsoid configuration under stromatic disc..Amphisphaeriaceae

5. Ascospores aseptate (rarely septate), often flattened, germ pore at tapered end, small (5-7 µm long mostly); asci clavate cylindric, stipitate, apical ring minute, nonamyloid; ascomata grouped in stromata in various configurations..............................Boliniaceae

5. Ascospores aseptate or septate, not flattened, with one or two terminal germ pores (or group of short slits); asci cylindric or clavate cylindric and stipitate, apical ring nonamyloid or amyloid; ascomata immersed singly or few under clypeus or singly to valsoid in interwoven hyphae Clypeosphaeriaceae

The Boliniaceae, Diatrypaceae, and Xylariaceae are not considered further in this article, except for restriction of the Boliniaceae to only *Camarops* and *Apiocamarops* (Nannfeldt 1972, Samuels and Rogers 1987). Barr (1990a) added *Rhynchostoma* to the Boliniaceae. That genus must be excluded however, for *R. minutum* P. Karst. has been shown to form a coelomycetous anamorph having holoarthric conidiogenesis (Constantinescu and Tibell 1992), whereas species of *Camarops* and *Apiocamarops* do not form anamorphs in culture (Horn 1984, Samuels and Rogers 1987). Barr (1993) also included *Pseudovalsaria* and *Endoxyla* in the Boliniaceae; these genera are again assigned (Barr 1990a) to the Clypeosphaeriaceae.

Amphisphaeriaceae

The genera accepted in the Amphisphaeriaceae have cylindric, short stipitate asci whose apices contain an amyloid or nonamyloid apical ring and a short pulvillus; all taxa have quite radially symmetric ascospores. The ascomata are immersed singly or in small groups in the substrate beneath a small or well developed, blackened clypeus or may become erumpent, then clypeal tissues are closely adherent to the peridium. Less frequently, the ascomata are grouped in valsoid configuration in stromatic tissues. The genera accepted in the family are diverse in ascospore pigmentation, shape, septation and wall ornamentation.

Anamorphs are associated (presumed) or are linked in culture in species of several genera. These are coelomycetous anamorphs whose holoblastic, monoblastic or percurrently proliferating conidiogenous cells produce hyaline or versicolorous, several-septate conidia that may bear setose appendages. These genera include: *Amphisphaeria argentinensis* Nag Raj - *Bleptosporium pleurochaetum* (Speg.) Sutton (Nag Raj 1977); *Broomella* spp.- *Pestalotiopsis*, *Truncatella* spp. (Shoemaker and Müller 1963, Nag Raj 1993); *Discostroma* spp. - *Seimatosporium*, *Sporocadus* spp. (Müller and Shoemaker 1965, Shoemaker and Müller 1964, 1965); *Griphosphaerioma kansensis*-*Labridella cornu-cervae* (Shoemaker 1963); *Lepteutypa* (and *Blogiascospora*) spp. - *Seiridium* spp. (Shoemaker and Müller 1965, Nag Raj 1993); *Pestalosphaeria* spp.- *Pestalotiopsis* spp. (Barr 1975, Nag Raj 1985).

Other genera, such as *Amphisphaerella*, *Crassoascus*, and *Dyrithium*, that are morphologically similar in teleomorphs but that are not known to possess anamorphs are also included in the family. *Urosporella* is removed from the Amphisphaeriaceae on the bases of asci forming a basal layer and the presumed coelomycetous anamorph of *U. magnoliae* (Ellis & Everh.) M.E. Barr (Barr 1966). The species may eventually be assigned to the Hyponectriaceae, but further evaluation is required.

Key to Genera of Amphisphaeriaceae

1. Ascospores aseptate, brown, several germ pores in equatorial ring or in two groups..........*Amphisphaerella*
1. Ascospores septate, hyaline or brown, usually lacking germ pore, occasionally with terminal group of short slits..2
    2. Ascospores hyaline or lightly pigmented.........3
    2. Ascospores brown (end cells hyaline or lightly pigmented at times); ascomata single or few beneath clypeus..4
3. Ascomata in valsoid configuration beneath stromatic disc; ascospores 1-septate...............*Griphosphaerioma*
3. Ascomata single or few beneath clypeus; ascospores 1- or several septate, rarely muriform...........*Discostroma*
    4. Ascospores 1-septate, wall smooth or ornamented... *Amphisphaeria*
    4. Ascospores 2- or more septate..................5
5. Ascospores 2-septate, wall longitudinally striate...... *Pestalosphaeria*
5. Ascospores 3- or more septate.......................6
    6. Ascospores 3-septate..........................7
    6. Ascospores 3-4-7-septate or muriform............8
7. Ascospores with hyaline terminal cells, bearing elongate appendages, euseptate, wall smooth.....*Broomella*
7. Ascospores with brown terminal cells, lacking elongate appendages, distoseptate at times, wall usually ornamented, surrounded by narrow coating.......*Lepteutypa*
    8. Ascospores 3-4-7-septate, terminal cells often lighter brown..........................*Crassoascus*
    8. Ascospores 3-5-septate with longitudinal septum, terminal cells brown......................*Dyrithium*

Amphisphaerella includes species whose brown, one-celled ascospores contain several germ pores arranged either equatorially or in groups toward the poles, but not strictly terminally as they may be in other brown-spored taxa (Munk 1953, O. Eriksson 1966). The species known in North America at present include two whose ascus apical ring is amyloid: *A. dispersella* (Nyl.) O.E. Erikss., the type species of the genus on *Populus*, having ascospores 18-25 x 7.5-9(-12) µm, and a recently discovered species having larger ascospores, described below, and two whose ascus apical ring is nonamyloid: *Amphisphaerella xylostei* (Pers.: Fr.) Munk on *Lonicera* having ascospores 15-24(-26) x (7-)10-15 µm and *A. vaga* (Niessl in Rabenh.) O.E. Erikss. on *Clematis* having ascospores 10-14 x 6-7.5 µm. *Anthostomella hypsophila* Ellis & Everh. (Proc. Acad. Nat. Sci. Philadelphia 46: 338. 1894) is a synonymous name of *A. xylostei*. Descriptions of these species are available in Munk (1957) and O. Eriksson (1966). Other undescribed taxa are known and Krug (personal communication) is preparing a monograph of the genus.

Amphisphaerella deceptiva M.E. Barr, sp. nov. Fig. 1a,b

Ascomata immersa discreta vel aggregata clypeata globosa 300-400 µm diametro papillata. Asci 200-225 x 15-25 µm unitunicati cylindrici paraphysati, annuli apicali amyloidei. Ascosporae 24-30 x (10-)12-15 µm fuscae ellipsoideae unicellulares guttulatae uniseriatae, pori germinales aequatorii. Holotypus in ramis *Salicis*, "Canada: British Columbia: Sidney, 1 Jul 1991" a M.E. Barr n. 7640 lectus in DAOM et isotypus in NY depositus.

Ascomata immersed separately or few grouped beneath blackened clypeal tissues, globose, 300-400 µm diam; apex papillate, up to 200 µm wide and high, ostiole periphysate; peridium brown, ca. 20 µm wide, compressed rows of cells, surrounded by brownish hyphae in wood, clypeus dark reddish brown, hyphal in wood over ascomata, up to 200-250 µm deep. Asci 200-225 x 15-25 µm, cylindric; apical ring refractive, amyloid, 1-2 µm deep. Paraphyses narrow, guttulate. Ascospores 24-30 x (10-)12-15 µm, becoming dark brown, ellipsoid, one celled; wall smooth, thick; germ pores darkly margined in equatorial row; contents densely guttulate; uniseriate in the ascus.

In old branches, British Columbia.

Additional collections: (all Sidney) *Salix*, 4 Oct 1991, Barr 7788, 9 Dec 1991, Barr 7883, 21 Mar 1992, Barr 8026, 18 Jul 1993, Barr 8559; *Rhamnus purshiana* DC., 20 Jul 1991, Barr 7675; *Crataegus oxyacantha* L., 11 Jan 1993, Barr 8353 (DAOM).

The epithet is chosen because of the deceptive aspect of the ascospores: when first observed they appear to be uniseptate because of the closely aligned row of dark-walled germ pores, and they appear reticulately ornamented because of the densely guttulate cytoplasm. The ascospore lengths are greater than those of either *A. xylostei or A.*

dispersella, and the germ pores are conspicuous in their close equatorial arrangement and heavily pigmented walls.

Amphisphaeria has been the repository for many extraneous taxa having one-septate, brown ascospores, and species have been confused with species of *Didymosphaeria* (Melanommatales, Loculoascomycetes). Lectotypification with *A. umbrina* (Fr.) De Not. (Hawksworth and Sherwood 1981) allows recognition of the genus in the sense of modern authors, e.g., Müller and Arx (1962). Rather few species are accepted at present in North America. *Amphisphaeria umbrina, A. bufonia* (Berk. & Broome) Ces. & De Not., and *A. multipunctata* (Fuckel) Petr. are known from North America as well as Europe in branches of various deciduous trees. Some additional synonyms of *A. multipunctata* [given in error as *A. millipunctata* by Petrak and Müller and Arx, corrections noted by Shoemaker and LeClair (1975) and Samuels et al. (1987)] are *Didymosphaeria major* Ellis & Everh. (Bull. Torrey Bot. Club 24: 130. 1897) (Barr 1989b) and *Didymella corylina* Ellis & Everh. (Bull. Torrey Bot. Club 25: 504. 1898). A specimen on *Isomeris* (C.F. Baker, Pacific Slope fungi 4047 det. as *Thyridium lividum*, NY) is also this species. *Amphisphaeria serrulata* (Ellis & G. Martin) M.E. Barr, having longitudinally striate ascospores, on palms and larger grasses, and *A. pardalina* (Ellis & Everh.) M.E. Barr, having ascospores with one to three slits at each end, on *Spartina*, were redescribed by Barr (1989b). *Amphisphaeria aspera* Ellis & Everh. is a species of *Dothidotthia* (Pleosporales, Barr 1989a).

A species on periderm of *Juniperus*, having longitudinally striate ascospores, does not fit any species described on that host; it is smaller than *A. juniperi* Tracy & Earle and is newly described below.

Amphisphaeria arizonica M.E. Barr, sp. nov. Fig. 1c

Ascomata immersa erumpentia globosa 495-550 µm diametro papillata clypeata. Asci 140-150 x 13-15 µm unitunicati cylindrici paraphysati, annuli apicali nonamyloidei. Ascosporae 18-22(-27) x 8-9(-10) µm fuscae ellipsoideae uniseptatae longistrosum striatae uniseriatae. Holotypus in corticis *Juniperi deppeanae* Steud., "USA: Arizona: Santa Cruz Co., Madera Canyon, Santa Rita Mts., 11 Aug 1980" a M.E. Barr n. 6814 lectus in NY depositus.

Ascomata immersed erumpent, nearly globose, 495-550 µm diam; apex stout papillate; peridium up to 40 µm wide below, compressed rows of brown cells, thickened above to 50-60 µm by closely adhering clypeus. Asci 140-150 x 13-15 µm; apical ring nonamyloid. Paraphyses narrow. Ascospores 18-22(-27) x 8-9(-10) µm, dark brown, ellipsoid, one-septate, constricted; wall finely longitudinally striate; one globule and several guttules in each cell; uniseriate in the ascus.

Known from the type collection.

Key to North American species of *Amphisphaeria*

1. In branches and periderm of woody plants; clypei usually rounded and small over single ascomata...........2
1. In culms of grasses or petioles of palms; clypei often merging as blackened blotches over several ascomata......5
    2. Ascospores 12-18(-24) x (5-)6-8 µm, wall smooth or verruculose; ascomata sphaeroid......*A. multipunctata*
    2. Ascospores (15-)18-24(-30) µm long..............3
3. Ascospores 18-22(-27) x 8-9(-10) µm, wall longitudinally striate; ascomata globose.............*A. arizonica*

3. Ascospore wall smooth or verruculose, not striate; ascomata sphaeroid to nearly globose....................4
    4. Ascospore wall verruculose, usually surrounded by gel coating, (15-)18-24(-30) x 7-10 µm; ascomata sphaeroid...............................*A. bufonia*
    4. Ascospore wall smooth, lacking gel coating, 16.5-27.5 x 9-11 µm; ascomata nearly globose....*A. umbrina*
5. Ascospore wall longitudinally striate, (15-)17-24 x 5-7(-8) µm; ascomata globose...................*A. serrulata*
5. Ascospore wall bearing 1-3 terminal slits, 20-24(-27) x 7-9 µm; ascomata sphaeroid...................*A. pardalina*

Broomella montaniensis (Ellis & Everh.) E.Müll. & S.Ahmad (Fig. 1f) is the only representative of the genus known in North America. This species was redescribed by Shoemaker and Müller (1963) with the presumed anamorph *Pestalotia pestalozzioides* (Dearn. & Fairm. in Fairm.) Shoemaker & E. Müll. [as *Truncatella pestalozzioides* (Dearn. & Fairm. in Fairm.) Shoemaker, Babcock & E. Müller, Shoemaker and Müller 1963).

Crassoascus was recently described for *C. fusisporus* Barassa, Checa & A.T. Martinez (Barassa et al. 1993), as a member of the Clypeosphaeriaceae. The brown ascospores, 40-45 x 8-10 µm, are typically 4-septate, have a large median cell and pallid end cells bearing delicate terminal protrusions or papillae at both ends. Several collections from British Columbia have shorter ascospores that are 3-7-septate with a median septum, and lack papillate tips to the pallid end cells. They evidently comprise another taxon in the genus.

Crassoascus canadensis M.E. Barr, sp. nov. Fig. 1d,e

Ascomata immersa discreta vel gregaria sphaeroidea 300-500 µm lata 200-350 µm alta papillata clypeata parva. Asci 110-160 x 15-20 µm unitunicati cylindrici vel oblongi paraphysati, annuli apicali amyloidei. Ascosporae 26-38 x 8-12 µm flavobrunneae vel avellaneae vel pallidae extrema versis fusoideae 3-7-septatae uniseriatae vel biseriatae. Holotypus in ligno *Salicis*, "Canada: British Columbia:

Sidney, 4 Oct 1991" a M.E. Barr 7787 lectus in DAOM et isotypus in NY depositus.

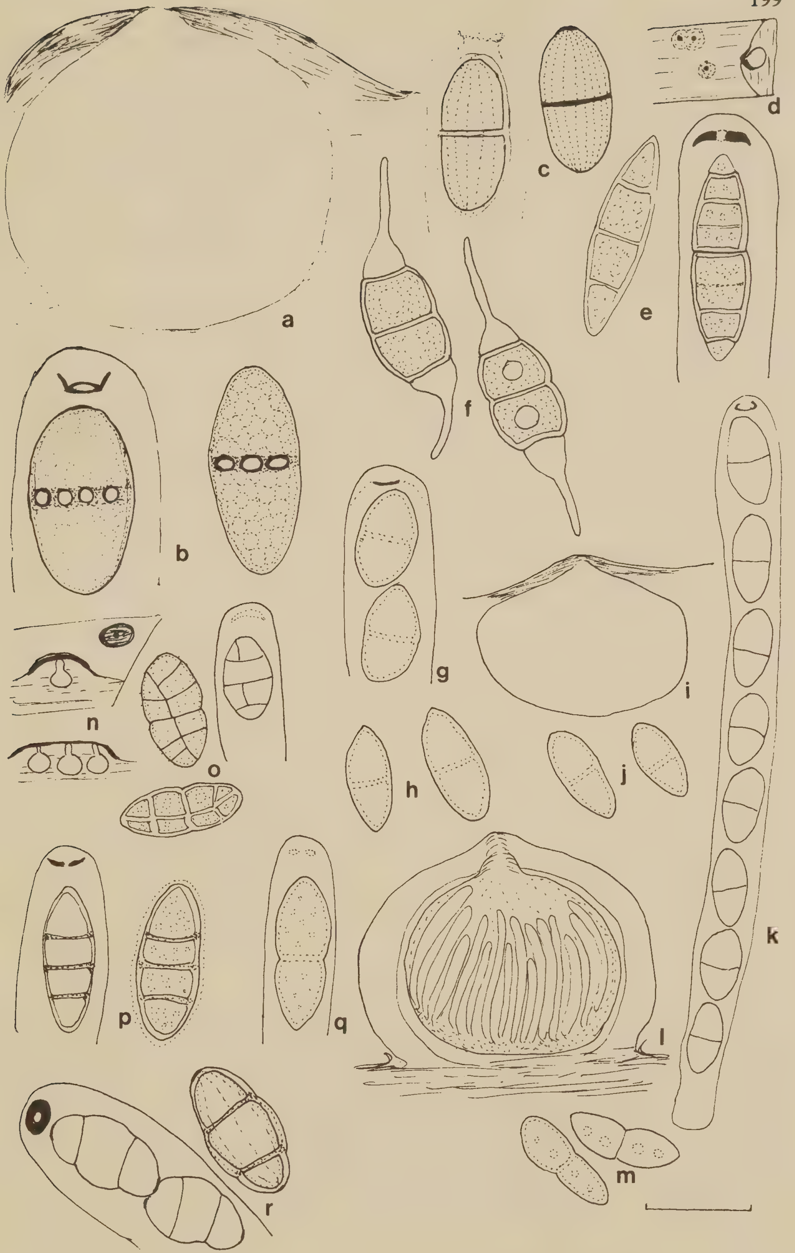
Ascomata immersed, scattered to gregarious, sphaeroid, 300-500 µm wide, 200-350 µm high; apex papillate, ostiole periphysate; peridium reddish brown, compressed cells, 20-25 µm wide, darkened aroung papilla as small clypeus. Asci 110-160 x 15-20 µm, unitunicate, cylindric to oblong, short stipitate; apical ring narrow, amyloid. Paraphyses delicate, guttulate, 2-3(-4) µm wide. Ascospores 26-38 x 8-12 µm, light yellowish brown to bright brown, end cells hyaline or light brownish, fusoid, 3-7-septate, slightly constricted at median septum; wall smooth; guttulate; uniseriate to partially biseriate in the ascus.

In wood or periderm of woody plants, British Columbia.

Additional collections: (all Sidney) *Acer macrophyllum* Pursh, 27 Mar 1991, Barr 7489; *Cornus occidentalis* Coville, 7 Jun 1991, Barr 7606 (DAOM).

Two other recently described genera have similar ascospores, fusoid, 5-7-septate, with hyaline or pallid end cells, but in asci whose apical ring is nonamyloid. *Ascotaiwania lignicola* Sivan. & H.S. Chang (Sivanesan and Chang 1992) forms oblique to horizontal, laterally short beaked ascomata on the wood surface and appears to belong in the Amphisphaeriaceae. *Herbampulla crassirostris* Scheuer & Nograsek has immersed, beaked ascomata, nearly cylindric asci, and was assigned to the Diaporthales (Scheuer and Nograsek 1993). This fungus has superficial similarities to *Trematosphaeria pachycarpa* (Sacc. & Marchal) Shoemaker & Babcock (Shoemaker and Babcock 1989), a loculoascomycetous member of the Melanommatales, and was originally determined as that species (Nograsek 1990), in the new genus *Botanamphora* Nograsek & Scheuer, now a synonym of *Trematosphaeria*.

Fig. 1. Amphisphaeriaceae. a, b. *Amphisphaerella deceptiva*, a. immersed clypeate ascoma in outline, b. ascus apex, ascospores. c. *Amphisphaeria arizonica*, ascus apex, ascospores. d, e. *Crassoascus canadensis*, d. habit of clypeate ascomata in branch, e, ascus apex, ascospores. f. *Broomella montaniensis*, ascospores. g. *Discostroma empetri*, ascus apex, ascospores. h. *D. hyperboreum*, ascospores. i, j. *D. ledi*, i. immersed clypeate ascoma in outline, j. ascospores. k. *D. rhododendri*, ascus, ascospores. l, m. *D. pachystimae*, l. erumpent clypeate ascoma in section, m. ascospores. n, o. *Dyrithium lividum*, n, habit of clypeate ascomata in wood, n. ascus apex, ascospores. p. *Leuteutypa hippophaes*, ascus apex, ascospores. q. *Griphosphaerioma kansensis*, ascus apex, ascospore. r. *Pestalosphaeria concentrica*, ascus apex, ascospores. Standard line = 15 µm for asci and ascospores, 150 µm for ascomata. Habits X ca. 10.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Discostroma. Three species studied by Brockmann (1976) in Europe are known from North America also: *D. massarinum* (Sacc.) Brockmann, *D. fuscella* (Berk. & Broome) Huhndorf (Huhndorf 1992) [as *D. corticola* (Fuckel) Brockmann], and *D. tostum* (Berk. & Broome) Brockmann. These three are the type species of *Discostroma and Clathridium*, *Griphosphaeria*, and *Paradidymella*, respectively, all presently arranged under *Discostroma*. Brockmann utilized *Seimatosporium* for species with appendaged conidia, *Sporocadus* for species lacking appendages, but Sutton (1980) included them all under *Seimatosporium*. Nag Raj (1993) analyzed the various taxa attributed to *Seimatosporium* and concluded that five genera should be segregated, two of them having teleomorphs in *Discostroma*. The connections for the three species noted above are: *D. massarinum* - *Seimatosporium ribis-alpini* (Corda) Shoemaker & E. Müll. (Shoemaker and Müller 1964, Brockmann 1976) [Nag Raj included this name as a synonym of *S. salicinum* (Corda) Nag Raj, and suggested that a different species could be the anamorph of *D. massarinum*]; *D. fuscella* - *S. lichenicola* (Corda) Shoemaker & E. Müll. (Shoemaker and Müller 1964), *Sporocadus lichenicola* Corda (Brockmann 1976); *D. tostum* - as *Seimatosporium kriegerianum* (Bres.) Morgan-Jones & B. Sutton (Müller and Shoemaker 1965), as *S. passerinii* (Sacc.) Brockmann (Brockmann 1976) [but *Diploceras kriegeriana* (Bres.) Nag Raj with teleomorph *Discostromopsis callistemonis* Swart (Nag Raj 1993)].

Discostroma propendulum (P. Karst.) Brockmann [as (B. Erikss.) Brockmann] is known in North America as well as Europe (B. Eriksson 1974) on *Arctostaphylos*. *Discostroma hyperboreum* (P.Karst.) O.E. Erikss. (O. Eriksson 1992) (Fig. 1h) develops in leaves of *Cassiope tetragona* (L.) D.Don., circumpolar in arctic regions. L. Holm (1975a) described it under the synonymous name *Griphosphaeria hyperborea* (P.Karst.) L.Holm. *Mycosphaerella immersa* Dearn. (Rep. Canad. Arctic Exped. 1916-18, 4C: 6. 1923) is another synonym (Barr 1959). *Discostroma muricatum* (Ellis & Everh.) M.E. Barr was redescribed by Barr (1983). Two other species, *D. cupulum* (Ellis) M.E. Barr and *D. rubicola* (Ellis & Everh.) M.E. Barr, were added to the genus from North American collections (Barr 1993). Four new species are described and an additional new combination is proposed below.

Discostroma empetri M.E. Barr, sp. nov. Fig. 1g

Ascomata immersa globosa 200-290 µm diametro papillata clypeata, peridia ca. 15 µm lata. Asci 80-93 x 9-10.5 µm unitunicati cylindrici paraphysati, annuli apicali amyloidei. Ascosporae 12-13.5(-15) x 5.5-7(-8) µm hyalinae ellipsoideae obtusae uniseptatae uniseriatae. Holotypus in foliis *Empetri nigri* L. "USA: Alaska: Aleutian Islands, a T. P. Banks Jr. n. 501 lectus in NY depositus.

Ascomata immersed, globose, 200-290 µm diam, apex papillate, surrounded by circular, somewhat shining black clypeus; peridium ca. 15 µm wide. Asci 80-93 x 9-10.5 µm; apical ring narrow, amyloid. Ascospores 12-13.5(-15) x 5.5-7(-8) µm, hyaline, ellipsoid, ends obtuse, 1-septate, slightly constricted.

Known from the type collection.

This species and two newly described taxa on members of the Ericaceae, *D. ledi* and *D. rhododendri*, are rather similar to one another and to *D. hyperboreum*, but are recognizable as distinct by ascospore sizes and shapes and extent of clypeus development.

Discostroma ledi M.E. Barr, sp. nov. Fig. 1i, j

Ascomata immersa sphaeroidea vel globosa, 200-245 µm lata 175-245 µm alta papillata clypeata, peridia 16-20 um lata. Asci 63-75 x 6-7 µm unitunicati cylindrici paraphysati, annuli apicali amyloidei. Ascosporae 10.5-12 x 4-4.5 µm hyalinae ellipsoideae obtusae uniseptatae uniseriatae. Holotypus in foliis *Ledi groenlandici* Oed. "Canada: Quebec: Mont Albert, trail near falls" a M.E. Barr n. 1938c lectus in NY depositus.

Ascomata immersed, 200-245 µm wide, 170-245 µm high, apex papillate beneath shallow clypeus; peridium 16-20 µm wide. Asci 63-75 x 6-7 µm; apical ring narrow, amyloid. Paraphyses narrow. Ascospores 10.5-12 x 4-4.5 µm, hyaline, ellipsoid, ends obtuse, 1-septate, not constricted.

Known from the type collection. Some three-septate, brown conidia, ca. 18 x 6 µm, were found and perhaps are referable as a species of *Sporocadus*.

Discostroma pachystimae M.E. Barr & Rogerson, sp. nov. Fig. 1l, m

Ascomata erumpentia discreta vel aggregata sphaeroidea 330 µm lata 275 µm alta papillata clypeata peridis adhaerens. Asci 80-100 x 7-7.5 µm unitunicati cylindrici paraphysati, annuli apicali amyloidei tarde. Ascosporae 12-14 x 4.5-5 µm hyalinae ellipsoideae fusoideae uniseptatae uniseriatae. Holotypus in ramunculis *Pachystimae myrsinites* (Pursh) Rafinesque, "USA: Utah: Weber Co., Taylor Canyon, Wasatch Mts. E. of Ogden, 14 Jul 1983" a C.T. Rogerson lectus in NY depositus.

Ascomata erumpent, separate or two or few coalescent, sphaeroid, ca. 330 µm wide, 275 µm high; papilla short, ostiole periphysate; peridium hyaline, ca. 32 µm wide of pseudoparenchymatous cells externally, compressed cells internally, beneath stromatic covering of blackish, pseudoparenchymatous cells ca. 50 µm wide. Asci 80-100 x 7-7.5 µm, unitunicate, cylindric, apical ring very narrow, slowly amyloid. Paraphyses narrow, numerous. Ascospores 12-14 x 4.5-5 µm, hyaline, ellipsoid fusoid, 1-septate, slightly constricted, rarely 3-septate; wall smooth; two globules per cell; uniseriate in the ascus.

Known from the type collection.

Discostroma rhododendri M.E. Barr, sp. nov. Fig. 1k

Ascomata immersa gregaria in maculis sphaeroideae 200-220 µm lata 150-180 µm alta papillata clypeata, peridia ca. 15 µm lata. Asci 60-88 x 6.5-9 µm unitunicati cylindrici paraphysati, annuli apicali amyloidei. Ascosporae 10-13 x 4.5-5.5 µm hyalinae oblongae ellipsoideae obtusae uniseptatae uniseriatae. Holotypus in foliis *Rhododendri californici* Hook. "USA: Oregon, Rhododendron, 5 Nov 1930" a J.R. Hansbrough n. 324 lecti in NY depositus sub *Sphaerella rhododendri* Cooke.

Ascomata gregarious, immersed in dead portion of living leaf containing *Mycosphaerella clintoniana* (House) House, sphaeroid, 200-220 µm wide, 150-180 µm high, papillate; peridium 15 µm wide, darkened over apex as small, closely adherent clypeus. Asci 60-88 x 6.5-9 µm; apical ring narrow, amyloid. Ascospores 10-13 x 4.5-5.5 µm, hyaline, oblong ellipsoid, ends obtuse, 1-septate, not or slightly constricted.

Known from the type collection.

Discostroma succineum (Roberge in Desm.) M.E. Barr, comb. nov.; basionym: *Sphaeria succinea* Roberge in Desm. Ann. Sci. Nat. ser. 3, 10: 354. 1848. This species differs from *D. cupulum* in smooth-walled, hyaline ascospores rather than delicately longitudinally striate, light brown ascospores. It is known from USA, in grayish spots in living leaves of *Quercus agrifolia* Née, California: Mendocino Co., Jackson State Forest, 15 Apr 1983, H.E. Bigelow (NY). The species was redescribed by Petrak (1927) under *Paradidymella* and by Müller (in Müller and Arx 1962) under *Leiosphaerella* from Europe.

Key to North American Species of *Discostroma*

1. Ascomata in coriaceous leaves; ascospores 1-septate...2
1. Ascomata in herbaceous stems or woody branches; ascospores 1- or several septate............................7
    2. In leaves of *Quercus* (rarely *Castanea*)...........3
    2. In leaves of Ericaceae or Empetraceae............4
3. Ascospores 11-13(-16.5) x 5-6.5 µm, becoming light brown, wall finely verruculose forming longitudinal striae *D. cupulum*
3. Ascospores 13-16 x 5-6 µm, hyaline, wall smooth........ *D. succineum*
    4. Ascospores 13.5-16(-18) x 5.5-7.5 µm, ends acute; clypeus small, closely adherent to apex, in *Cassiope*. *D. hyperboreum*
    4. Ascospores 10-13.5(-15) µm long, ends obtuse.....5
5. Ascospores 12-13.5(-15) x 5.5-7(-8) µm; clypeus well developed over ascomata, in *Empetrum*...........*D. empetri*
5. Ascospores 10-13 x 4-5.5 µm.........................6

6. Clypeus well developed over ascomata, in *Ledum*.... *D. ledi*

6. Clypeus small, closely adherent to apex; in *Rhododendron*........................*D. rhododendri*

7. Ascospores 1-septate...............................8

7. Ascospores 3-5-6-septate...........................9

8. Ascospores 10-14 x 3.5-5 µm; ascomata immersed and clypeate, in stems of *Epilobium*; ....*D. tostum*

8. Ascospores 12-14 x 4.5-5 µm; ascomata erumpent, few grouped beneath stromatic covering, in twigs of *Pachystima*...........................*D. pachystimae*

9. Ascomata superficial, surrounded by soft stroma of large, pseudoparenchymatous cells; ascospores light dull brown, 18-20(-34) x 8-10(-12.5) µm...........*D. muricatum*

9. Ascomata immersed beneath clypeus or erumpent and grouped beneath stromatic covering; ascospores hyaline to light brown.......................................10

10. Ascospores 11-18(-20) x 5-7(-8) µm; in various woody plants...........................*D. fuscella*

10. Ascospores larger...........................11

11. Ascospores 19-22(-24) x 10-13 µm; in *Arctostaphylos*... *D. propendulum*

11. Ascospores (5.5-)6-10 µm wide......................12

12. Ascospores 15.5-24 x 6.5-9 µm, 3-septate; in canes of *Rubus*.........................*D. rubicola*

12. Ascospores 15-28 x (5.5-)6-10 µm, 3-5-septate and usually one longitudinal septum in one or more cells; in branches of *Ribes*..................*D. massarinum*

Dyrithium. Although relatively few dictyosporous taxa are known in the Hymenoascomycetes as compared to the Loculoascomycetes, one such is a member of the Amphisphaeriaceae. *Thyridium lividum* (Pers.: Fr.) Sacc. was named as type of the genus by Clements and Shear (1931), but that was certainly not Nitschke's original concept (L. Holm 1975b, Barr 1983). Many species assigned to *Thyridium* have bitunicate asci and are thus excluded (Barr 1990b); only *T. vestitum* (Fr.) Fuckel is presently accepted in that genus (Barr 1983, 1990b) which belongs in the Thyridiaceae. *Thyridium vestitum* differs conspicuously from *T. lividum* by valsoid configuration of ascomata in interwoven, reddish stromatic tissues. According to Berlese (1897, Pl. CIII, f. 1), in *T. lividum* several ascomata are immersed in darkened pulvinate stromatic tissues in wood. Dennis (1978) illustrated a single ascoma in wood beneath raised ellipsoid blackened clypeus. A specimen in Fries' herbarium (*Sphaeria livida* Fr. E. Galie (?) Levieux... Herb. E. Fries, UPS) has one to five ascomata beneath elongate raised clypei, as do some North American collections. The species does not belong in any of the dictyosporous genera that I am aware of and a new genus is proposed to accommodate it.

Dyrithium M.E. Barr, gen. nov. (anagram of *Thyridium*)

Ascomata immersa solitaria vel pauca papillata vel rostellata sub clypeis elevatis denigratis ellipsoideis. Asci unitunicati cylindrici paraphysati, annuli apicali nonamyloidei. Ascosporae fuscae ellipsoideae muriformia. Species typicus *D. lividum* (Fr.) M.E. Barr

Ascomata immersed, separate or few beneath raised, blackened, ellipsoid clypeus, at times extended as blackened marginal zone at sides and toward base of ascoma, globose; papilla or short beak stout; peridium narrow. Asci unitunicate, cylindric, short stipitate, apical ring shallow, nonamyloid. Paraphyses narrow. Ascospores dull brown, ellipsoid, muriform. Type species *D. lividum* (Fr.) M.E. Barr

Dyrithium lividum (Fr.) M.E. Barr, comb. nov. Fig. 1n,o

Sphaeria livida Fr. Syst. Mycol. 2: 479. 1823.

Teichospora livida (Fr.) P. Karst., Mycol. Fenn. 2: 68. 1873.

Thyridium lividum (Fr.) Sacc. Michelia 1: 50. 1877; Syll. Fung. 2: 324. 1883.

Fenestella livida (Fr.) G. Winter in Rabenh. Kryptogamen-Flora von Deutschland... 1(2): 796. 1885.

Xylosphaeria livida (Fr.) Petr., Sydowia 4: 19. 1950.

Mycothyridium lividum (Fr.) Petr., Sydowia 15: 289. 1961 (1962).

Ascomata immersed in wood, single or few beneath dark gray to blackish, arched, ellipsoid clypeus, 1-2 mm long, up to 1 mm wide, of small brown cells and hyphae surrounding substrate cells, at times extending around ascomata; ascomata globose, 300-440 µm; apex wide, papillate to short beaked, 165-300 µm high, 110-220 µm wide, opening to surface; peridium narrow, 10-20 µm, externally brown small pseudoparenchymatous cells, internally hyaline compressed cells. Asci 80-100 x 9-14 µm, 8-spored or less; pulvillus chitinoid; apical ring shallow, nonamyloid. Paraphyses numerous, narrow. Ascospores 12-20 x 7-10 µm, dull brown, ellipsoid, 3-5-septate with one longitudinal septum in mid or all cells; wall punctate, appearing finely verruculose; granular; uniseriate in the ascus.

In old wood. CANADA: Newfoundland: Bay of Islands, Rev. Waghorne 688 (NY). USA: Iowa: *Juniperus communis* L., Decorah, 31 Aug 1882, E. W. Holway 139 (NY). Texas: *Juniperus ashei* Buchholz, Austin, Oct 1975, R.T. Jackson, det. M.Sherwood, UPS ex CUP 54852. Vermont: *Thuja*, Cedar Swamps, Addison Co., Munkton, 19 Jun 1879, C.G. P(ringle). (NY). PUERTO RICO: Mona Island, Punta Capitan, 7 Jun 1992, coll. S. Cantrell, comm. D. J. Lodge PR 907 part via S. Huhndorf (NY).

Sphaeria garryae Cooke & Harkness may be an additional synonym. The specimen in NY from Harkness is overmature, but is similar to those cited above in external features. However, the descriptions as *Thyridium* in Ellis and Everhart (1892) and as *Peltosphaeria* in Berlese (1897) are of a species with much larger, seven to nine transversely septate ascospores, in appearance more like a species of *Peltosphaeria (= Julella)* than *Thyridium* or *Dyrithium*.

Griphosphaerioma kansensis (Ellis & Everh.) Shoemaker (Fig. 1q) has short-beaked ascomata that develop in valsoid configuration among brownish stromatic tissues. *Labridella cornu-cervae* Brenckle is the anamorph. Shoemaker (1963) redescribed and illustrated the species.

Lepteutypa. As Samuels et al. (1987) pointed out, when they compared species of *Lepteutypa* and *Pestalosphaeria*, the three-septate brown ascospores in *L. fuckelii* (Nitschke in Fuckel) Petr. appear to be distoseptate. The septa are often incomplete and are marked by an accumulation of brown granules. The ascospore wall is smooth and surrounded by a firm, narrow hyaline layer, not expanding in water as most gel coatings do. Several collections that fit in *Lepteutypa* have verruculose or irregular walls within the outer coating and pigmentation is more intense than in the smooth-walled but octagonal ascospores of the type species or in *L. hippophaes* (Fabre) Arx, the type species of *Hymenopleella* (Munk 1953). Ascomata in *Lepteutypa* are quite similar in appearance to those in *Discostroma* and are immersed and clypeate or at times may be erumpent and grouped under a common covering. Apices are papillate or short beaked.

Shoemaker and Müller (1965) described *L. fuckelii* as well as *L. hippophaes* (under *Hymenopleella)*, with *Seiridium*-like anamorphs from European specimens. *Lepteutypa hippophaes* has smooth-walled ascospores with mid cells shorter than end cells (Fig. 1p). A collection on *Ceanothus velutinus* Douglas ex Hook. (USA: California: Loomis Peak Trail, Lassen Volcanic Nat'l Park, 17 Aug 1957, W.B. & V.G. Cooke 30904, NY) agrees well with *L. hippophaes*. *Lepteutypa fuckelii* is not yet known convincingly from North America, although a collection on *Celastrus scandens* (USA: Massachusetts: Franklin Co., Pine Hill, Conway, 25 Nov 1979, M.E. Barr 6627, NY) is close and is deposited under that name. The ascospores are not octagonal, but they are delicately longitudinally striate. The presence of *L. cupressi* (Natrass, C. Booth & B. Sutton) H.J. Swart in North America is inferred from the anamorphs *Seiridium unicorne* (Cooke & Ellis) B. Sutton (Guba 1961, Sutton 1980) and *S. cardinale* (Wagener) Sutton & Gibson (Nag Raj 1993). Three species, *L. alpestris* (Ellis & Everh.) M.E. Barr, *L. sabalicola* (Ellis & G. Martin) M.E. Barr, and *L. ulmicola* (Ellis & Everh.) M.E. Barr were redescribed and illustrated by Barr (1993).

Key to North American Species of *Lepteutypa*

1. Ascospores typically octagonal in end view or longitudinally striate, (13-)18-22 x (4.5-)5-7.5 µm....*L. fuckelii*
1. Ascospores not octagonal in end view nor longitudinally striate..2
    2. Ascospore wall smooth, brown....................3
    2. Ascospore wall verruculose, reddish brown........5
3. Ascospores typically with short, somewhat darker mid cells than end cells, 18-25 x 6-9 µm.........*L. hippophaes*
3. Ascospores with mid and end cells about equal in length and pigmentation......................................4
    4. Ascospores 14-23(-27) x 6-9 µm.........*L. cupressi*
    4. Ascospores 20-27 x 5-7.5 µm...........*L. alpestris*
5. Ascospores narrow, 11-15.5 x 3.5-5 µm, in clavate cylindric asci; ascomata usually gregarious beneath clypeus.. *L. sabalicola*
5. Ascospores wider, 16.5-21(-28) x 6-9 µm, in cylindric asci; ascomata usually separate beneath clypei........... *L. ulmicola*

Pestalosphaeria was described for *P. concentrica* M.E. Barr (Barr 1975) (Fig. 1r) in leaves of *Rhododendron maximum* L., with *Pestalotiopsis guepinii* (Desm.) Steyaert var. *macrotricha* (Kleb.) B. Sutton as anamorph. This is the only North American species but several others have been described, typically having two-septate ascospores. Nag Raj (1985) summarized information on five species and Samuels et al. (1987) added another. Zhu et al. (1991) described two more species from China. According to van der Aa's (1986) revision of *Keissleriella podocarpi* Butin and disposition to *Lepteutypa*, this species probably belongs in *Pestalosphaeria* also.

Clypeosphaeriaceae

The family includes taxa whose ascospores are radially asymmetric, flattened or slightly incurved on one side. The ascospores are brown, may have a small pallid end cell, and usually contain one or two germ pores or a group of short slits at one end. The asci are cylindric or clavate cylindric and stipitate and often contain a conspicuous refractive pulvillus over the amyloid or nonamyloid apical ring. Stromatic tissues form as darkened clypei over single immersed ascomata or may be closely adherent to peridium of erumpent ascomata, or as interwoven hyphae surrounding one or more ascomata that may be grouped in valsoid configuration. Anamorphs are not yet known in the family.

Key to Genera of Clypeosphaeriaceae

1. Ascomata single or few beneath dark clypeus..........2
1. Ascomata single or grouped, surrounded by interwoven

hyphae, apical ring of ascus nonamyloid..................3

  2. Ascospores 2-septate with short pallid end cell; apical ring of ascus nonamyloid......*Apiorhynchostoma*

  2. Ascospores 1-septate with short pallid end cell or 3-septate and brown; apical ring of ascus amyloid or nonamyloid........................*Clypeosphaeria*

3. Ascomata in valsoid configuration; ascospores 1-septate *Pseudovalsaria*

3. Ascomata single or few grouped........................4

  4. Immersed in wood; ascospores aseptate or 1-(rarely 2-)septate, at times with short pallid end cell...... *Endoxyla*

  4. Erumpent superficial on substrate; ascospores 1-septate (rarely aseptate).................*Jobellisia*

Apiorhynchostoma curreyi (Rabenh.) E. Müll. in Müller and Arx (1962) is the type species of the genus, known from North America (as *Sphaeria altipeta* Peck) as well as Europe. Petrak (1923) and Müller in Müller and Arx (1962) provided descriptions of this species. *Apiorhynchostoma tumulatum* (Cooke) Sivan. is known from wood of *Pinus contorta* Douglas ex Loud. in California (Sierra Nevada, W. H. Harkness 1014, K) and has ascospores with a delicate hyaline appendage at the end opposite the small pallid cell. They measure 25-35 x 9-12 µm (Sivanesan 1975), larger than those of *A. curreyi* (Fig. 2c) which measure 15-18(-27) x 4.5-6.5(-9) µm.

Clypeosphaeria was re-evaluated by Barr (1989c) who at that time knew only *C. americana* M.E. Barr & Samuels in North America. *Clypeosphaeria mamillana* (Fr.: Fr.) Lambotte is now known from western Canada on several woody host plants [*Arbutus menziesii* Pursh, *Cornus nuttallii* Audubon, *C. occidentalis*, *Holodiscus discolor* (Pursh) Maxim., *Lonicera ciliosa* (Pursh) Poir., *Quercus garryana* Douglas, *Rosa* sp., *Rubus laciniatus* Willd.]. The ascomata may be separate with only the black papillate apex erumpent or separate or few under a conspicuous black clypeus in twigs, or gregarious under a darkened widespread clypeus in wood (Fig. 2a), much as in *Sphaeria hemitapha* Berk. & Broome, one of the synonymous names. All other features, including those of ascospore septation (Fig. 2b), are in accord with the variations described in Barr (1989c) and Huhndorf (1992), although most ascospores in the species are delicately three septate.

Endoxyla was investigated by Untereiner (1993). She accepted five species in the genus, all but the type species *E. macrostoma* Fuckel known from North America. She considered a number of families in her efforts to assign the genus and finally left it in the Clypeosphaeriaceae, suggested by Barr (1990a). Barr (1993) added *E. luteobasis* to the genus. This species has grouped ascomata that are surrounded by yellowish, furfuraceous hyphae. The uniseptate ascospores are most similar to those of *E. parallela* (Fr.: Fr.) Fuckel, and are smaller, 9-12 x 2-2.5 µm.

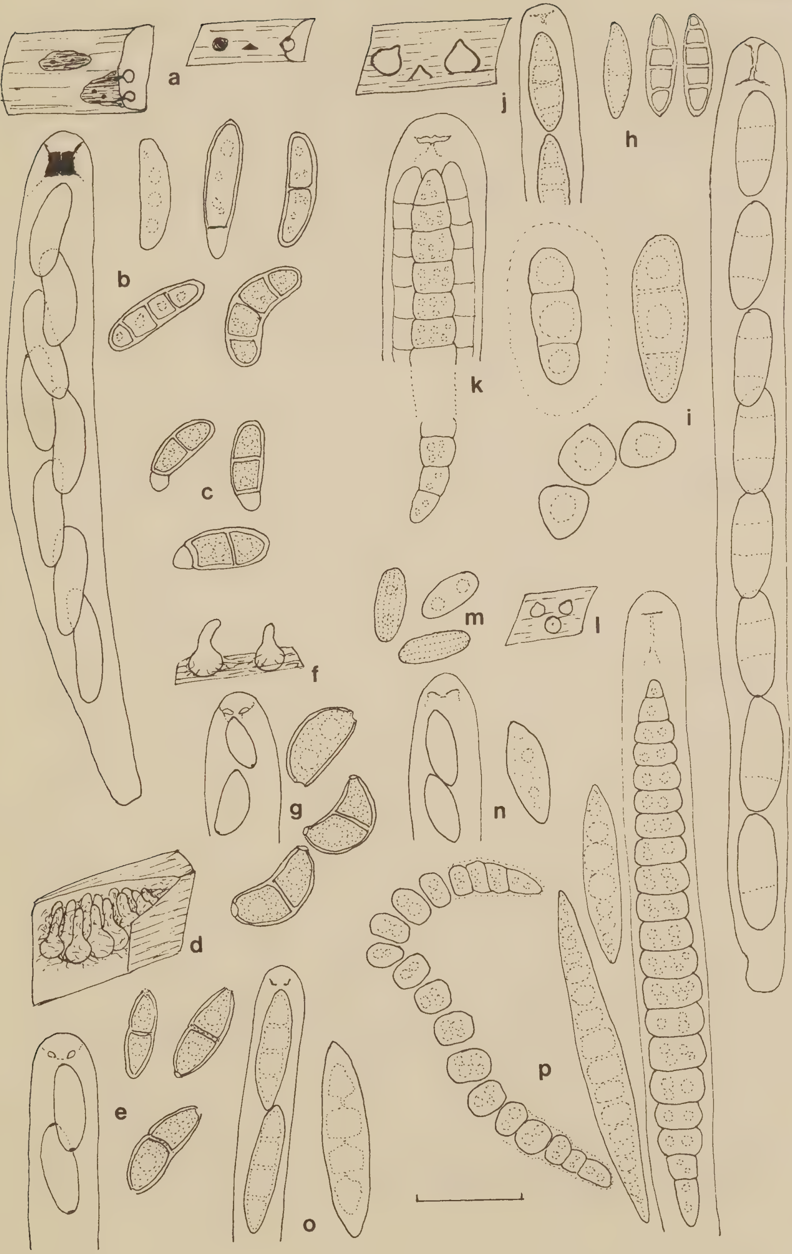
The hyaline-spored species that have traditionally been assigned to *Ceratostomella* (Arx 1952, Dennis 1978, Eriksson and Hawksworth 1991), also have been synonymized under *Endoxyla* (Arx and Müller 1954, Munk 1957, 1965). The two genera are quite different. Even though species of *Ceratostomella* are saprobic in wood, the asci are truly diaporthaceous in structure, and the genus must be assigned to the Diaporthales. Its precise position awaits another re-evaluation of certain taxa in the Melanconidceae. *Endoxyla avocetta* (Cooke & Ellis) Romero & Samuels (Romero and Samuels 1991) should be removed to a position among these taxa at the appropriate time.

Jobellisia was described for two species, *J. luteola* (Ellis & Everh.) M.E. Barr and *J. nicaraguensis* (Ellis & Everh.) M.E. Barr, having brown, broadly ellipsoid, aseptate or one-septate ascospores (Barr 1993). An additional taxon is transferred to this genus. It was originally described from Europe and is also known in North America. The ascomata are erumpent separately or few gregarious.

Jobellisia rhynchostoma (Höhn.) M.E. Barr, comb. nov.
Fig. 2f,g
Letendraea rhynchostoma Höhn., Sitzungsber. Kaiserl. Akad. Wiss. Math.-Naturwiss. Kl. Abt. 1, 116: 108. 1907.

Ascomata separate or gregarious, erumpent to superficial, globose, 350-660 µm diam; beaks stout, 385-520 µm high, 160-300 µm wide, ostioles periphysate; peridium externally reddish to dark brown, small pseudoparenchymatous cells, 40-60 µm wide, up to 100 µm wide as closely adhering stromatic layer around beaks, internally hyaline,

Fig. 2. a-g. Clypeosphaeriaceae. a,b. *Clypeosphaeria mamillana*, a. habit of forms in wood (left) and twig (right), b. ascus and variation in ascospores. c. *Apiorhynchostoma curreyi*, ascospores. d, e. *Pseudovalsaria peckii*, d. habit of grouped ascomata, e. ascus apex and ascospores. f, g. *Jobellisia rhynchostoma*, f. habit of ascomata, g. ascus apex, ascospores. h-p. Pleurotremaceae. h. *Pleurotrema polysemum*, ascus apex and ascospores. i. *Melomastia mastoidea*, ascus and stages in development of ascospores. j, k. *Daruvedia bacillata*, j. habit of ascomata, k. ascus apex, uppermost and lowermost cells of ascospore. l, m. *Phomatospora striatispora*, l. habit of ascomata, m. ascospores. n. *P. lithocarpi*, ascus apex, ascospores. o. *Saccardoella macrasca*, ascus apex, ascospores. p. *S. separans*, ascus apex, stages in development of ascospores. Standard line = 15 µm for asci and ascospores. Habits X ca. 10.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10 µm wide. Asci 65-90 x 6-11(-14.5) µm, cylindric, 8-spored or less; apical ring shallow, nonamyloid, pulvillus chitinoid. Paraphyses narrow, numerous, 1-3 µm wide. Ascospores 9-15 x 4.5-7.5 µm (up to 15.5-20 x 7.5-9 µm in few-spored asci), grayish brown becoming dark brown, ellipsoid to navicular, inequilateral, one side flattened or slightly curved, one celled or one septate; wall smooth, one or two terminal germ pores; one globule per cell; uniseriate in the ascus.

In pericarps and old wood. AUSTRIA: pericarps of *Juglans regia* L., Prater (Donau) near Vienna, 19 Aug 1906, F. v.Höhnel 2845, holotype (Höhnel Herb. in FH). Additional collections: USA: Massachusetts: *Carya* pericarp, Franklin Co., Roaring Brook Road, Conway, 11 Nov 1961, M.E. Barr 3176. North Carolina: *Robinia pseudoacacia* L. wood, Transylvania Co., 3 mi S of Saphire, 6 Jul 1972, J. Menge 204 (both NY).

Key to Species of *Jobellisia*

1. Ascomata immersed to erumpent, apex stout beaked; ascospores 9-15 x 4.5-7.5 µm...............*J. rhynchostoma*
1. Ascomata erumpent superficial, apex papillate.........2
    2. Ascomata surrounded by yellowish brown, stromatic tissues; ascospores 9-15(-16) x 4-6 µm.....*J. luteola*
    2. Ascomata surrounded by crustose, dark brown stromatic layer; ascospores 10-12 x 4.5-5 µm......... *J. nicaraguensis*

Pseudovalsaria was erected for *P. foedans* (P. Karst.) Spooner (Spooner 1986), a species separated from *Valsaria* by the type of stroma and by nonornamented ascospores that contain one germ pore. Spooner did not assign the genus to a family, although he inclined toward the Trichosphaeriaceae. Spooner redescribed and illustrated the species. He included the synonymous names *Phaeosperma niesslii* G. Winter and *Valsaria lignicola* Teng & S.H. Ou, noted collections on several substrates (*Alnus*, *Betula*, *Castanea*, *Pinus*, *Prunus*, *Quercus*, *?Viburnum*) in Europe and China. Barr (1990a) arranged the genus in the Clypeosphaeriaceae and added *Valsaria moroides* (Cooke & Peck) Sacc. as another synonymous name, on *Alnus* in eastern North America. The fungus is also known in North America on *Betula* from Massachusetts (Barr 1789, NY, as *Valsaria niesslii*) and on *Salix* from Idaho (A.W. Slipp 434, NY).

Pseudovalsaria allantospora (Ellis & Everh.) M.E. Barr (Barr 1993) was redescribed and illustrated by Shoemaker and Egger (1982). Another taxon is inserted in the genus.

Pseudovalsaria peckii (Howe in Peck) M.E. Barr, comb. nov. Fig. 2d,e

Valsa peckii Howe in Peck, Rep. New York State Mus. 27: 109. (for 1873) 1875.

Valsaria peckii (Howe in Peck) Sacc. Syll. Fung. 1: 746. 1882.

Ascomata closely gregarious in valsoid configuration, as rounded or ellipsoid areas surrounded by dark brown prosenchymatous stromatic tissues around beaks; ascomata globose or ovoid, 400-800 µm; beaks 770-1000 µm high, 150-200 µm wide, erumpent together, ostioles periphysate; peridium externally dark reddish brown compressed rows of cells, 20-30 µm wide, internally 6-10 µm wide, pallid. Asci cylindric. 90-120 x 7.5-10 µm; apical ring shallow, nonamyloid, pulvillus chitinoid. Paraphyses numerous, delicate, 1-1.5 µm wide. Ascospores 12-15.5(-17) x 4.5-5.5 µm, soon dark brown, oblong ellipsoid, straight or slightly curved, 1-septate, heavily pigmented each side of septum; wall smooth or finely verruculose, two terminal germ pores; one or two globules per cell; uniseriate in the ascus.

In ericaceous branches. USA: Connecticut: *Vaccinium atrococcum* (Gray) Heller, near Willimantic, 25 Aug 1979, M.E. Barr 6583. New Jersey: *V. corymbosum* L., Newfield, J.B. Ellis N.A.F. 171 (NY). New York: *Kalmia latifolia* L., Forestburgh, C.H. Peck (NYS, holotype); *V. corymbosum*, Albany Co., Vorheesville, 18 Apr 1925, H.D. House 606 (NYS).

Key to Species of Pseudovalsaria

1. Ascospores 9-13 x 2-5 µm; in various trees...*P. foedans*
1. Ascospores longer; substrates restricted..............2
    2. Ascospores 12-15.5(-17) x 4.5-5.5 µm; in ericaceous branches........................*P. peckii*
    2. Ascospores 11-16.5(-20) x 3.5-5.5 µm; in *Acer*..... *P. allantospora*

Pleurotremaceae

The family Pleurotremataceae Walt. Watson (New Phytol. 28: 112. 1929) was erected for *Pleurotrema polysemum* (Nyl.) Müll. Arg., the sole species, and has been considered to be lichenized. Eriksson (1981) redescribed and illustrated this organism, which has horizontal ascomata beneath a blackened clypeus that open by short lateral apices, the ostioles periphysate. He considered that the species was lichenized and suggested that the family could be synonymized under the Pyrenulaceae (Pyrenulales or Melannomatales, i.e., among the Loculoascomycetes.) Although Eriksson indicated that the asci were bitunicate but not fissitunicate, his Fig. 186b shows a definite narrow ring in the ascus apex, as did my examination of isotype material from NY. Eriksson and Hawksworth (1991) have Pleurotremataceae as a questionable synonym of Pyrenulaceae, while Poelt (1973) assigned *Pleurotrema* to the Strigulaceae. Aptroot (1991) synonymized the genus under *Lithothelium* as a member of the Pyrenulaceae. Recently, R. Harris (personal communication) examined the NY isotype of *Pleurotrema polysemum*, determined that it is a nonlichenized fungus, that the short-stipitate, cylindric asci are unitunicate, and suggested that it could be related to *Melomastia* and *Saccardoella*. I concur with his findings, and remove the family to a position in the Xylariales, where it accommodates several other genera having hyaline, symmetric, frequently distoseptate ascospores in short stipitate, cylindric asci whose apical ring is narrow and nonamyloid and whose pulvillus is indistinct. The ascospores of *P. polysemum* (Fig. 2h) are evidently distoseptate, according to Luttrell's (1963) definition of the condition. They do not have lenticular lumina such as are found in species of *Massaria* or *Pyrenula*, for example, but rectangular median cells. Development of septation is macrocephalic (Eriksson 1981), with most ascospores three septate, but one or two additional septa may be formed.

With the insertion of *Phomatospora* into this family, the invalid name Phomatosporaceae Arx [Antonie van Leeuwenhoek 17: 271. 1951; nom. inval. Art. 36.1, Art. 32.1(b), Hawksworth and David 1989] is included.

Only for a few species in *Phomatospora* are any anamorphs known: *Dinemasporium strigosum* (Pers.: Fr.) Sacc. for *P. dinemasporium* Webster (Webster 1955), and species of *Sporothrix* for *P. berkeley* Sacc. and *P. arenaria* Sacc., E. Bommer & M. Rousseau (Rappaz 1992). Because these anamorphs are so dissimilar, this genus may not represent a single entity upon detailed scrutiny.

Key to Genera of Pleurotremaceae

1. Ascospores aseptate (rarely 1-septate), in herbaceous stems, monocot culms, coriaceous leaves.......*Phomatospora*
1. Ascospores septate, in wood or periderm...............2
    2. Ascospores oblong, 2-septate...........*Melomastia*
    2. Ascospores fusoid, elongate or filiform, 3- to multiseptate...3
3. Ascomata horizontal, short apex lateral; asci parallel to substrate surface; ascospores 3-septate.....*Pleurotrema*
3. Ascomata upright or tilted, short apex central or eccentric; asci perpendicular to substrate surface.......4
    4. Ascospores fusoid to elongate, 3-30-septate....... *Saccardoella*
    4. Ascospores filiform, up to 50-septate....*Daruvedia*

Daruvedia was erected recently by Dennis (1988) to accommodate *Sphaeria bacillata* Cooke, with synonymous name *Rhaphidophora macrocarpa* Sacc. As Dennis observed, *Acerbia* cannot be utilized for this species; in the type species *A. hyptidis* (Henn.) Sacc. the ascospores are nonseptate and relatively short. In addition, the description of rugulose ascomata and comparison to *Ophioceras longispora* (Ellis) Sacc. suggests that *Acerbia* is a member of the Lasiosphaeriaceae (Sordariales), as is *Sphaeria longispora* Ellis. This taxon is lasiosphaeriaceous according to the type specimen, whose ascomata have a short papillate apex composed of dark setae, and required a new name, *Lasiosphaeria ellisii* M.E. Barr (Barr 1993) when transfer was made to that genus. Berlese (1899) provided illustrations of *"Acerbia" bacillata*, showing stout, erumpent ascomata, long cylindric ascus and filiform ascospores that are closely septate with up to 50 septa, the apex obtuse and tapering to the narrow base. Berlese also suggested that *Sphaeria longispora* could be the same, and Ellis and Everhart (1892) mentioned *S. longispora* as possibly identical to *Acanthostigma decastylum* (Cooke) Sacc. This latter species has distantly setose ascomata, shorter, 3-5-septate ascospores 22-30 x 4-4.5 µm, and was compared to *A. atrobarbum* (Cooke & Ellis) Ellis & Everh. which is properly *Chaetosphaeria atrobarba* (Cooke & Ellis) Sacc. *Acanthostigma decastylum* is surely also a species of *Chaetosphaeria*.

While I agree with Dennis that *Sphaeria bacillata* requires a separate genus, I disagree on its disposition. The asci are unitunicate and the fungus is most closely related to *Melomastia mastoidea* (Fr.) Schröt. and species of *Saccardoella*. Locally, *Lonicera ciliosa* is host to *Daruvedia bacillata*, *Melomastia mastoidea* and a new species of *Saccardoella*, and it is impossible to tell which of these fungi is in hand by their macroscopic appearance. The stout-walled, strongly papillate ascomata, the thick peridium composed of numerous rows of compressed reddish brown cells, and the centrum of long cylindric asci and narrow paraphyses in a gel matrix are shared characteristics. The asci do have a thickened wall at the apex that is penetrated by a narrow canal that bears a narrow refractive apical ring. In water mounts the asci in all three species tend to break and release the ascospores, but not in a bitunicate fashion, i.e., lacking an extendable endoascus. The ascospores of *Daruvedia bacillata* differ from those of other scolecosporous taxa in their close septation and do not have any internal cells that are enlarged. Such a fungus was illustrated by Shoemaker (1976) as *Ophiobolus lonicerae* Fabre from California, the ascospores multiseptate and lacking any enlarged cells. This name is surely another synonym of *D. bacillata* as Berlese (1899) had suggested. Because of the difficulty of access to Dennis's article, the synonymy and a description of this species follows.

Daruvedia bacillata (Cooke) Dennis, Belarra 2(4): 25. 1988. Fig. 2j,k

Sphaeria bacillata Cooke, Handbook Brit. Fungi 2: 879. 1871.

Ceratostomella (Ophioceras) bacillata (Cooke) Cooke, Grevillea 17: 50. 1889.

Ophioceras bacillata (Cooke) Sacc. Syll. Fung. 2:

360. 1883.

Acerbia bacillata (Cooke) Berl. Icon. Pyrenomyc. 2 : 142. 1899.

Rhaphidophora macrocarpa Sacc. Nuovo Giorn. Bot. Ital. 7: 306. 1875.

Ophioceras macrocarpa (Sacc.) Sacc. Syll. Fung. 2: 359. 1883.

Ophiobolus lonicerae Fabre, Ann. Sci. Nat. Ser. 6, 15: 62. 1883.

Ascomata loosely gregarious, immersed, apex erumpent, nearly globose, 500-700 µm diam; apex stoutly papillate, ostiole periphysate; peridium 40-60 µm wide, dark reddish brown, numerous rows of compressed cells. Asci (130-)180-220(-350) x 10-14(-18) µm, apex thickened, narrow canal surrounded by narrow, refractive nonamyloid apical ring. Paraphyses narrow, 1-1.5 µm wide, in gel matrix. Ascospores 130-200(-250) x (2.5-)4-5-(6) µm, hyaline to slightly yellowish in mass, filiform, apex obtuse, base tapered, up to 50 or more septate, slightly constricted at septa; wall smooth, guttulate, finally one globule per cell; parallel in fascicle in the ascus.

In old branches of *Hedera*, *Ampelopsis*, *Catalpa*, *Fraxinus* (Europe), *Lonicera* (Europe, North America).

Material examined: Canada: British Columbia: *Lonicera ciliosa*, Sidney, 26 May 1991, M.E. Barr 7576, 28 Oct 1991, M.E. Barr 7828.

Duradens was described recently for *D. lignicola* Samuels & Rogerson (Samuels and Rogerson 1990), a taxon that was distinguished by the extremely thick carbonized peridium. Asci and ascospores resemble those of *Daruvedia bacillata*, although both are wider and the ascospores are infrequently septate. Samuels and Rogerson referred *Duradens* to the Clypeosphaeriaceae but the genus probably should be assigned to the Pleurotremaceae.

Melomastia mastoidea (Fr.) J. Schröt. in Cohn is the type species of the genus and the sole species that I recognize. It is known from Europe and western North America, on assorted old woody branches.

Melomastia mastoidea (Fr.) J. Schröt. in Cohn, Kryptogamen-Fl. Schlesien 3(2): 320. 1894. Fig. 2h,i

Sphaeria mastoidea Fr. Syst. Mycol. 2: 463. 1823.

Trematosphaeria mastoidea (Fr.) G. Winter in Rabenh. Kryptogamen-Fl. 1(2): 274. 1885.

Melomastia friesii Nitschke in Fuckel, Jahrb. Nassauischen Ver. Naturk. 25-26: 306. 1871.

Metasphaeria macounii Dearn. Mycologia 8: 100. 1916.

Ascomata gregarious, immersed, apex erumpent, globose, 300-800 µm diam; apex stoutly papillate, ostiole periphysate; peridium dark blackish brown, numerous rows of compressed cells, 40-50 µm wide, thickened above as closely adherent clypeus to 125 µm wide. Asci 120-200 x

6-10 µm, cylindric, short stipitate; apical ring narrow, nonamyloid, pulvillus enlarged but usually indistinct, nonchitinoid. Paraphyses narrow, guttulate. Ascospores (12.5-)16-20(-25) x 4.5-7.5(-8) µm, hyaline, oblong, 2-septate, constricted, occasionally separating into partspores at septa; wall smooth, sometimes verruculose in age, surrounded by delicate gel coating 2-4 µm wide when fresh; usually one large globule per cell; uniseriate in the ascus.

In old periderm and wood of various shrubs and trees.

Material examined: CANADA: BRITISH COLUMBIA: *Rosa*, Comox, Jun 1915, J. Macoun 637a (holotype of *Metasphaeria macounii*, Dearness Herb. in DAOM); (all Sidney except where noted otherwise, various dates) *Acer macrophyllum*, M.E. Barr 7264, 7488; *Arbutus menziesii* Pursh, Barr 7955; *Berberis aquifolium* Pursh, Barr 8134; *Gaultheria shallon* Pursh (Mill Bay), Barr 7395; *Holodiscus discolor*, Barr 8202, 8242, 8259; *Ilex aquifolium* L., Barr 8590; *Lonicera ciliosa*, Barr 7378, 7458, 7472, 7565, 7620, 7647, 7703, 7757, 7942, 7945, 7984, 8041, 8190, 8343; *L. hispidula* (Lindl.) Douglas ex Torr. & A. Gray, Barr 7269, 7346, 7770, 7810, 7816, 7917, 8384, 8434; *L. involucrata* (Richardson) Banks ex Spreng., Barr 7221, 7491, 7612, 8179, 8196, 8262; *Philadelphus lewisii* Pursh, Barr 7192, 7408,7728, 7901, 8068, 8326, 8472; *Populus tremuloides* Michx., Barr 7254; *Rhamnus purshiana*, Barr 7171, 7431, 7674, 7724, 8059, 8125; *Ribes divaricatum* Douglas, Barr 7477; *R. sanguineum* Pursh, Barr 8021; Rubus parviflorus Nutt., Barr 7276; *R. spectabilis* Pursh, Barr 7684; *Sambucus callicarpa* Greene, Barr 7245; *Symphoricarpos albus* (L.) S.F. Blake, Barr 7447, 7912, 8300 (all DAOM). USA: California: *Sambucus callicarpa*, Marin Co., Muir Woods, 7 Dec 1971, M.E. Barr 5950b (NY).

Phomatospora is typified by *P. berkeleyi* Sacc., a plurivorous species that Rappaz (1992) has shown to produce a *Sporothrix* anamorph in culture. The European *P. arenaria* Sacc., E. Bommer, & M. Rousseau on *Ammophila* has similar ascomata but ascospores differ in size and shape (Eriksson 1967). The *Sporothrix* anamorph also differs (Rappaz 1992). *Gnomoniella asparagina* Rehm (Ann. Mycol. 10: 390. 1912; Krieger, F. saxonici 2216, TRTC) is a synonymous name of *P. berkeleyi*. *Phomatospora dinemasporium* J. Webster, on Poaceae, forms a different type of anamorph, *Dinemasporium strigosum* (Pers.: Fr.) Sacc., in culture and has narrow, elongate ascospores (8-)9-16 x (2-)3-4 µm (Webster 1955).

Physalospora minutella (Peck) Sacc. is removed from synonymy of *P. berkeleyi* (Barr et al. 1986) and is recognized as a separate species, *Phomatospora minutella* (Peck) M.E. Barr, comb. nov.; basionym: *Sphaeria minutella* Peck, Ann. Rep. New York State Mus. 29: 62. (for 1875) 1878. This collection has small ascospores that lack longitudinal striae. No anamorph has beem associated.

Another species that is similar to *P. berkeleyi* in wall striations but has larger ascospores without pulvinate appendages appears to be undescribed.

Phomatospora striatispora M.E. Barr, sp. nov. Fig. 21,m

Ascomata gregaria superficialia globosa 440-495 µm diametro papillata. Asci 80-110 x 7-8 µm unitunicati cylindrici paraphysati, annuli apicali nonamyloidei. Ascosporae 12-14 x 5-6 µm hyalinae oblongae unicellulares longistrorsum striatae uniseriatae. Holotypus in caulibus *Cowaniae mexicanae* D. Don., "USA: Utah: Bryce Canyon Nat'l Park, Paria Lookout, 21 Aug 1973" a M.E. Barr n. 6150a in NY depositus.

Ascomata gregarious, appearing superficial on decorticated stem bases, globose, 440-495 µm diam; apex papillate; peridium ca. 20 µm wide, dark reddish brown, compressed rows of cells. Asci 80-110 x 7-8 µm, cylindric; apical ring shallow, nonamyloid. Paraphyses delicate, deliquescent. Ascospores 12-14 x 5-6 µm, hyaline, oblong, ends obtuse, one celled; wall delicately longitudinally striate; two globules; uniseriate in the ascus.

Known from the type collection.

Phomatospora angelicae (Fuckel) Mouton (including *Sphaerella angelicae* Ellis & Everh.) usually occurs on umbellifers and has more fusoid ascospores that appear to be finely verruculose and may develop a median septum (the basis for *Phomatosporopsis* Petr.) *Phomatospora leptasca* (Peck & G.P. Clinton) J. Reid & C. Booth (Reid and Booth 1966) develops over old ascomycete stromata. *Phomatospora therophila* (Desm.) Sacc. on *Carex* and *Juncus* forms small clypei and the oblong ascospores may bear caplike appendages; this species is considered by some to belong in *Phyllachora* e.g., Arx and Müller (1954). Scheuer (1988) added *P. striatigera* Scheuer on *Carex* with larger, fusoid, striate ascospores, (18-)22-30 x (3.5-)4-7 µm, and *P. radegundensis* Scheuer on *Scirpus*, with 1-3-septate, fusoid, verrucose ascospores, (9.5-)10-14(-15.5) x 2.2-3.5(-4) µm. Nograsek (1990) contributed *P. admontensis* Nograsek on *Carex*, whose fusoid, slightly veruculose ascospores are 3-(4-7-)septate and 17-26(-30) x 4-7(-8) µm.

Another series of species develops in coriaceous leaves and produces fusoid, one-celled ascospores. *Phomatospora clarae-bonae* (Speg.) M.E. Barr on *Vaccinium vitis-idaea* L. has the apices of ascomata composed of upright, parallel, hyaline hyphae surrounding the darkened minute papilla; ascospores are 13.5-20 x 4.5-6.5 µm (Barr 1970). *Phomatospora gelatinospora* M.E. Barr on *Rhododendron maximum* L. has a darkened apical papilla; ascospores are 15-18.5 x 5.5-7 µm, surrounded by a gel coating (Barr 1970). This species is also known from Britain (Dennis 1981). A third taxon in this group is described below.

Phomatospora lithocarpi M.E. Barr, sp. nov. Fig. 2n

Ascomata immersa gregaria globosa 330 µm diametro papillata. Asci 90-110 x 6-7.5 µm unitunicati cylindrici paraphysati, annuli apicali nonamyloidei. Ascosporae 13-16 x 4.5-5 µm hyalinae fusoideae unicellulares uniseriatae. Holotypus in foliis *Lithocarpi densiflorae* (Hook. & Arnott) Rehd., "USA: California: Yuba Co., Bullard's Bar, 17 Apr 1983" a H.E. Bigelow lectus in NY depositus.

Ascomata immersed, gregarious, globose, about 330 µm diam; apex papillate; peridium brown, ca. 20 µm wide around base and sides, up to 40 µm wide and darkened toward apex. Asci 90-110 x 6-7.5 µm, unitunicate, cylindric, apical ring shallow, nonamyloid, Paraphyses delicate, 1.5-2.5 µm wide, deliquescent. Ascospores 13-16 x 4.5-5 µm, hyaline, fusoid, one celled; wall smooth; two globules; uniseriate in the ascus.

Known from the type collection.

Key to North American Species of *Phomatospora*

1. Ascospores small, 6.5-8 x 2-3.5 µm, walls smooth......2
1. Ascospores larger or walls longitudinally striate.....3
    2. In herbaceous stems..................*P. minutella*
    2. In old ascomycete stromata............*P. leptasca*
3. In herbaceous stems or monocot leaves and culms.......4
3. In coriaceous leaves.................................8
    4. Ascospore wall longitudinally striate...........5
    4. Ascospore wall smooth...........................6
5. Ascospores 7-10.5 x 2.5-3.5 µm, often bearing pulvinate terminal appendages........................*P. berkeleyi*
5. Ascospores 12-14 x 5-6 µm, lacking terminal appendages. *P. striatispora*
    6. Ascospores 9-10.5 x 3-3.5 µm, oblong, bearing pulvinate terminal appendages..........*P. therophila*
    6. Ascospores narrower, fusoid.....................7
7. Ascospores 9.5-12(-16) x (2.5-)3.5-5(-6.5) µm......... *P. angelicae*
7. Ascospores (8-)9-16 x (2-)3-4 µm......*P. dinaemosporium*
    8. Minute black papilla surrounded by hyaline crown of parallel hyphae; ascospores 13.5-20 x 4.5-6.5 µm.. *P. clarae-bonae*
    8. Black papilla not surrounded by crown of hyphae..9
9. Ascospores 15-18.5 x 5.5-7 µm, surrounded by gel coating...................................*P. gelatinospora*
9. Ascospores 13-16 x 4.5-5 µm, lacking gel coating...... *P. lithocarpi*

Saccardoella. The known species have large, stoutly papillate ascomata, immersed to erumpent from old wood and periderm. The asci are cylindric and the apical ring is shallow, beneath a conspicuous or inconspicuous, refractive pulvillus, neither of them staining in IKI or ink.

The ascospores are uniseriate, hyaline, several septate or distoseptate and several celled without definite septa. The type species is *S. montellica* Speg., at this time known only from *Quercus* in Italy. Its ascospores are 100-115 x 12 µm and 20-30-septate (Berlese 1892, Mathiassen, personal communication).

Petrak (1961) provided an emended description of the genus, in which he recognized four species, and noted that it was related to *Melomastia*. Müller and Arx (1973) arranged both genera in the Sphaeriaceae. Barr (1990a) inserted them under the Clypeosphaeriaceae, while Eriksson and Hawksworth (1991) accepted *Melomastia* in that family but did not assign *Saccardoella* to a family.

Mathiessen (personal communication) has examined a number of the species. He has determined that *S. canadensis* Ellis & Everh. and *S. berberidis* Eliasson are not separable from *S. transsylvanica* (Rehm) Berl. This taxon evidently is the most widespread in distribution and substrate, although it is not common. Mathiessen recognizes another species from Norway in *Salix* wood (Mathiessen 1989, 1992). Hyde (1992) described and illustrated three species growing on mangrove wood in the southern hemisphere. One of these species, *S. mangrovei* K.D. Hyde, is known also from Florida (Huhndorf, personal communication). In addition to *S. transsylvanica* in eastern and central North America, a western taxon with ascospores intermediate in length between those of *S. montellica* and *S. transsylvanica*, is described as new. Another taxon is referrable to a species earlier assigned to *Zignoella*. [The type species of that genus is now recognized as a species of *Chaetosphaeria* (Müller in Eriksson and Hawksworth 1987) and the genus falls into synonymy.] Berlese (1892) had already suggested that some species described in *Zignoella* belonged instead in *Saccardoella*. One of these species, with cylindric asci and fusoid ascospores, is transferred to *Saccardoella*.

Saccardoella macrasca (Sacc.) M.E. Barr, comb. nov.
Fig. 2o
Zignoella macrasca Sacc. Michelia 2: 138. 1881.

Ascomata immersed, globose, 485-660 µm diam, with papilla erumpent 550-700 µm high; ostiole periphysate; peridium reddish brown, compressed rows of cells, 25-30 µm wide, brown hyphae extending into wood. Asci 100-150 x 6-9 µm. Paraphyses narrow, 1-2 µm, distantly septate. Ascospores 16-28(-36) x 4-5.5 µm, hyaline, fusoid, 3-septate (usually as four cells, without septa); wall smooth; uniseriate in the ascus.

In old wood. USA: Georgia: *Aucuba japonica* Thunb., Univ. Georgia Bot. Gardens, Athens, Clarke Co., 25 Aug 1978, M.E. Barr 6461. Massachusetts: *Populus balsamifera* L., Franklin Co., Conway, Baptist Hill, 9 Dec 1979, M.E. Barr 6642 (both NY).

These two collections agree well with descriptions and Berlese's illustration of *Z. macrasca*, although asci do not reach the length given originally (200 x 10 µm). The species was described from a Ravenel collection from Carolina and a specimen in FH (in the *Trematosphaeria mastoidea* folder) collected by Ravenel on ash is identical (J. Boise, personal communication).

Saccardoella separans M. E. Barr, sp. nov. Fig. 2p

Ascomata immersa erumpentia solitaria vel gregaria globosa 500-600 µm diametro papillata clypeata peridis adhaerens. Asci 300-400 x 10-12 µm unitunicati cylindrici paraphysati, annuli apicali angusti nonamyloidei. Ascosporae 65-85(-90) x 9-10 µm hyalinae elongatae fusoideae 18-23 septatae uniseriatae secedens in endosporae circa 5-6 x 8-9 µm. Holotypus in ramis *Lonicerae ciliosae*, "Canada: British Columbia, Sidney, 3 Jul 1991" a M.E. Barr n. 7646 lectus in DAOM et isotypus in NY depositus.

Ascomata immersed, apex erumpent, separate or gregarious, globose, 500-600 µm diam; apex short papillate, ca. 100-150 µm wide and high; peridium dark brown, 35 µm wide at base and lower sides, enlarged as clypeus or closely surrounding papilla, up to 100 µm wide, of compressed rows of cells, at times extended as blackened line in substrate. Asci 300-400 x 10-12 µm, extending in water mounts to 600 µm long, unitunicate, cylindric, (4-5-6-)8-spored; apical ring narrow, refractive, nonamyloid. Paraphyses narrow, to 2 µm wide, guttulate. Ascospores 65-85(-90) x 9-10 µm, hyaline, elongate fusoid, ends acute, 18-23-septate or septa lacking except for first-formed median septum, at maturity constricted and disarticulating into individual cells (endospores), ca. 5-6 x 8-9 µm; wall smooth, thickened, at times caplike terminal appendages; one or two globules per cell; overlapping uniseriate in the ascus.

In old woody stems and decorticated branches. Additional collections: CANADA: British Columbia: all Sidney, *Acer macrophyllum*, 27 Jul 1991, Barr 7680; *Lonicera ciliosa*, 29 Jul 1990, Barr 7232; 22 Jan 1991, Barr 7411; 9 Mar 1991, Barr 7459; 6 Apr 1991, Barr 7499; 25 Jan 1992, Barr 7946; 19 Apr 1992, Barr 8050; 22 Jun 1992, Barr 8136; *Lonicera hispidula*, 13 Nov 1992, Barr 8292; *Malus*, 7 Jul 1991, Barr 7652; *Rhamnus purshiana*, 20 Jul 1991, Barr 7673; 19 Aug 1991, Barr 7722; *Salix*, 9 Dec 1991, Barr 7884 (all DAOM).

Key to North American Species of *Saccardoella*

1. Ascospores less than 40 µm long........................2
1. Ascospores longer, (35-)40-90 µm long.................3
    2. Ascospores 21.5-32.5 x 6-7 µm.........*S. mangrovei*
    2. Ascospores 16-28(-36) x 4-5.5 µm.......*S. macrasca*
3. Ascospores (35-)40-75 x 8-10.5(-12) µm, 8-20-celled.... *S. transsylvanica*

3. Ascospores 65-90 x 9-10 µm, 18-24 celled....*S. separans*

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NEW SPECIES OF *PSILOCYBE* FROM COLOMBIA AND DISCUSSION ON THE KNOWN SPECIES

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ABSTRACT

The hallucinogenic fungi ***Psilocybe antioquensis***, ***P. guatapensis***, ***P. heliconiae*** and ***P. subacutipilea*** are described as new species from the Antioquia Department, Colombia. In addition, a check-list of the known species of ***Psilocybe*** from Colombia is presented and discussed.

INTRODUCTION

In continuation of the studies on the Colombian Agaricales (Pineda *et al.*, 1988; Saldarriaga *et al.*, 1988; Velázquez *et al.*, 1989), and in particular on the genus ***Psilocybe*** (Guzmán, 1978, 1983), descriptions of four new species of ***Psilocybe*** and discussions on the known species are presented. The material was studied in slides mounted in KOH 5 %, Melzer's reagent and cotton-blue in lactophenol.

DESCRIPTION OF THE NEW SPECIES

Psilocybe antioquensis Guzmán, Saldarriaga, Pineda, Garcia et Velázquez, sp. nov. Figs. 1-5

Stipite longo pseudorhizomorphico a Psilocybe mexicana Heim et Psilocybe acutipilea (Speg.) Guzmán differt et Psilocybe galindoi Guzmán sporis brevibus, (6-) 8-10 (-10.6) x (4.5-) 5.5-6.5(-7) µm differt.

Basidiocarpia in pratis ad terram. In regione subtropicali. Colombia, prope Antioquia, Medellín-Amalfi, Porce, Puente Gabino, Guzmán 29562-B, holotypus Herb. HUA; isotypus Herb. XAL.

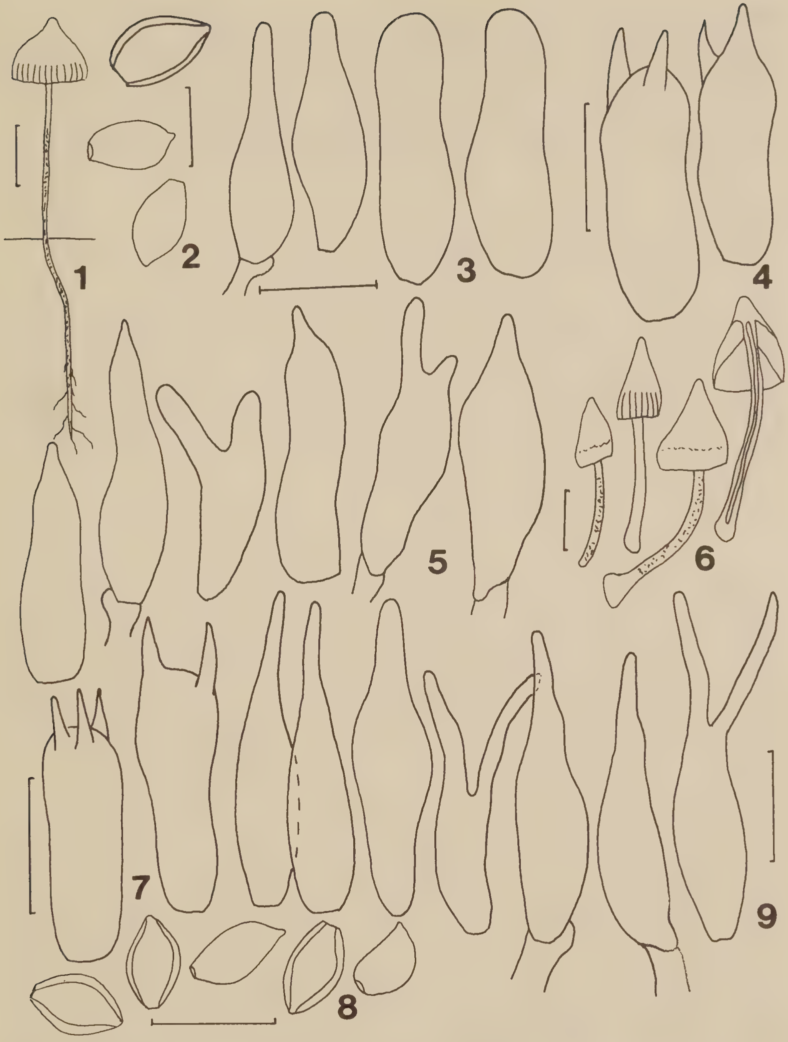
Pileus 5-12 mm in diameter, campanulate to subumbonate, subviscid or lubricous, glabrous, smooth or striate at the margin, hygrophanous, reddish-brown to fulvous, becoming straw color when dry. Lamellae sinuate, gray brownish to violaceous brown, with whitish subfloccose edge. Stipe 50-65 (including the pseudorhiza) x 0.8-2 mm, equal, flexuous, hollow, silky, but with floccose white fibrils toward the base, surface whitish to brownish or straw color, when injured turns reddish to darker, with a long pseudorhiza (± 3/4 part of the total length of the stipe). Veil silky-fibrillose, white, evanescent, leaving appressed fibrils on the margin of the pileus. Context thin, brownish in the pileus, whitish to reddish brown in the stipe, readily turning blue green when cut or injured. Odor and taste farinaceous. KOH stains readily pileus, stipe and context reddish brown. Spore print dark violaceous brown.

Spores (6-) 8-10 (-10.6) x (4.5-) 5.5-6.5 (-7) μm, subrhomboid in face view, subellipsoid in side view, thick-walled, yellowish brown, with a broad germ pore. Basidia 20-30 x 6-8 μm, 4-spored, sometimes 2-spored, hyaline, ventricose but with a median constriction. Pleurocystidia 15-23 x 3-8 μm, rare, hyaline, fusoid-ampullaceous with a short neck, sometimes ventricose or subcylindric. Cheilocystidia 15-20 x 4-6 μm, common, hyaline, fusoid-ampullaceous, papillate or with a short neck sometimes bifurcate or branched. Epicutis a subgelatinized layer, composed of parallel, hyaline hyphae 3-9 μm wide. Gill trama parallel, with hyphae 6-11 μm wide, hyaline to yellowish. Clamp connections present.

Habitat and distribution. Solitary or in small groups, in soil in a meadow with grazing grasses, in subtropical zone, at 1100 m alt. Known only from the type locality.

Studied material. COLOMBIA, Departamento Antioquia, Municipio Porce, near the road Medellín to Amalfi, zone of Puente Gabino, Aug. 31, 1990, **Guzmán 29562-B** (holotype HUA, isotype XAL); **Guzmán 29560-B; 29567-B; 29569-B** (all in HUA and XAL).

Discussion. This species is close to ***P. galindoi*** Guzmán known only from Mexico, but that has longer spores [(8.1-) 9.6-12 (-14) μm



Figs. 1-9. Two species of *Psilocybe*, 1-5: *P. antioquensis*, 1: basidioma (note the pseudorhiza), 2: spores, 3: pleurocystidia, 4: basidia, 5: cheilocystidia. 6-9: *P. guatapensis*, 6: basidiomata, 7: basidia, 8: spores 9: cheilocystidia (all from the type). Scale bar =10 mm in 1 and 6, =10 μm otherwise.

long] (Guzmán, 1983). It is also close to ***P. mexicana*** Heim and ***P. acutipilea*** (Speg.) Guzmán, the first known from Mexico and Guatemala and the later from Brazil, but they do not have pseudorhiza (Guzmán, 1983). ***P. antioquensis*** as the other mentioned species belongs to Sect. Mexicana, where all the species are characterized by hallucinogenic propierties.

Psilocybe guatapensis Guzmán, Saldarriaga, Pineda, García et Velázquez, sp. nov. Figs. 6-9

Differt a Psilocybe cordispora Heim et P. mammillata (Murr.) Smith pileo 8-12 mm lato, subcampanulato, stipite subbulboso, pleurocystidia nullo, cheilocystidia 16-28 x 3-5 μm, lageniformia et sporis (5.5-) 6-6.5 (-7) x 4-5 μm. Basidiocarpia ad terram argillacea. In zona subtropicali. Colombia, prope Antioquia, Guatapé, Guzmán 29571-B, holotypus Herb. HUA; isotypus Herb. XAL.

Pileus 8-12 mm in diameter, acute-campanulate, mamillate, lubricous, glabrous, even to slightly sulcate in the margin, hygrophanous, reddish brown to yellowish brown or yellowish orange. Lamellae subadnate, grayish brownish with violaceous tinges and whitish edges. Stipe 25-40 x 2-3 mm, equally, but at base subbulbous, hollow, flexuous, whitish to yellowish brown, covered by white subfloccose scales. Veil arachnoid, white, evanescent, leaving small appendages at the pileus margin. Context whitish in the pileus, pale brownish in the stipe. Odor and taste farinaceous. Readily turning blue green when injured.

Spores (5.5-) 6-6.5 (-7) x 4-5 μm, subrhomboid in face view, subellipsoid in side view, thick-walled, yellowish brown, with a broad germ pore. Basidia 18-20 x 5-6 μm, 2-, 3 or 4-spored, hyaline, ventricose with a median constriction. Pleurocystidia absent. Cheilocystidia 16-28 x 3-5 μm, abundant, forming an sterile band at the edge of the gill, hyaline, fusoid-ventricose or lageniform with a short or long, simple or bifurcate neck. Epicutis subgelatinous with postrated, smooth, hyaline to yellowish brown hyphae. Hyphodermium with irregular hyphae 5-19 μm in diameter, hyaline or brownish yellow, with incrustations on the walls. Gill trama with parallel hyphae 4-11 μm broad, hyaline, incrusted with brownish yellow pigment. Clamp connections present.

Habitat and distribution. Caespitose and gregarious, in orange brown clay soil covered by mosses, in a road embankment, in a subtropical forest with ***Podocarpus***, at 1850 m alt. Known only from the type locality.

Studied material. COLOMBIA, Departamento Antioquia, Municipio Guatapé, Finca Montepinar, Sept. 15, 1990, **Guzmán 29571-B** (holotype HUA, isotype XAL).

Discussion. This species is close to ***P. cordispora*** Heim known only from Mexico, but differs by the bulbous base of the stipe, the mamillate pileus, and the smaller cheilocystidia [(20-) 25-35 x 5-6 μm in ***P. cordispora***]. Other allied species is ***P. mammillata*** (Murr.) Smith, which lacks a bulbous stipe and differs also by its cheilocystidia 12-17 μm long (Guzmán, 1983). All these fungi, including ***P. guatapensis***, belong to Sect. Cordispora that have hallucinogenic properties.

Psilocybe heliconiae Guzmán, Saldarriaga, Pineda, García et Velázquez, sp. nov. Figs. 15-19

Differt Psilocybe wrightii Guzmán et P. brasiliensis Guzmán pleurocystidia subglobosa (11-) 14-17 x 5-7 (-9) μm et cheilocystidia longa (18-) 19-22 (-24) x (4-) 5-6 μm. Basidiocarpia ad terram, in sylva tropicali. Colombia, prope Antioquia, Nariño, Puente Linda, Parra s.n., holotypus Herb. HUA; isotypus Herb. XAL.

Pileus 20-30 mm in diam., subcampanulate, subumbonate, lubricous, glabrous, even to striate at the margin, brownish to chocolate brown, finally straw color, hygrophanous. Lamellae sinuate, yellowish, grayish brown to violet brown, with whitish edges. Stipe 35-45 x 4-5 mm, pale brown to yellowish brown, cylindric, slightly thickened at the base, somewhat flexuous, hollow or stuffed of white mycelium, subpruinose to floccose with whitish scales toward the base. Context whitish under the pileus, brownish in the stipe. Odor and taste farinaceous. All parts staining blue green when injured. KOH negative or stains the pileus pale brownish.

Spores 5-6.5 (-7.5) x 4-6 μm, subrhomboid or subellipsoid in face view, subellipsoid in side view, thick-walled, yellowish brown, with a broad germ pore. Basidia 18-20 x 5-6 μm, 2-, 3 or 4-spored, hyaline, ventricose with a median constriction. Pleurocystidia (11-) 14-17 x 5-7 (-9) μm, hyaline, subglobose or ventricose. Cheilocystidia (18-) 19-22

(-24) x (4-) 5-6 μm, abundant, hyaline, sublageniform, ventricose-fusoid or sometimes submoniliform, with a short neck or slightly mucronate at apex. Epicutis a subgelatinous layer, 80 μm thick, with subparallel hyaline hyphae of 2-3 μm in diam. Gill trama parallel, with hyaline hyphae. Clamp connections present.

Habitat and distribution. Solitary or caespitose, on soil in tropical rain forest, at 500-1000 m alt. Known only from the regions of Nariño and Caquetá in Antioquía Department, at Colombia. One of the studied specimens brought from Caquetá (**Parra & Echeverry 2**) grew at a flowerpot with ***Heliconia*** in a greenhouse in Medellín.

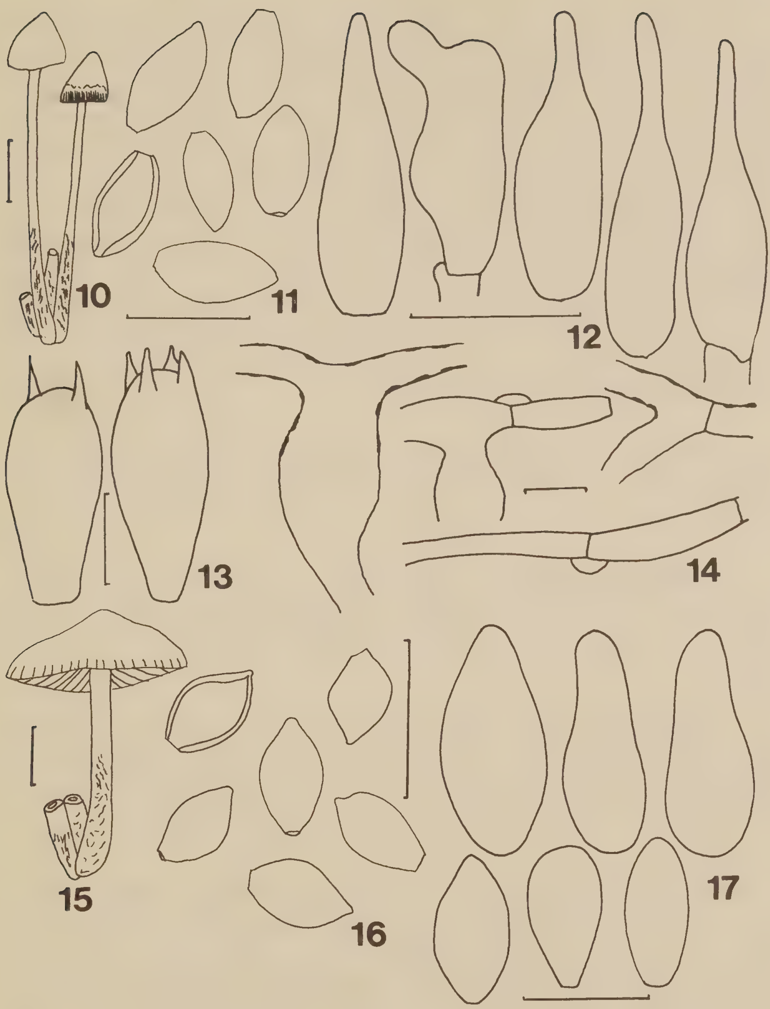
Studied material. COLOMBIA, Departamento Antioquia, Nariño region, Puente Linda, Sept. 15, 1990, **G. Parra** s.n. (holotype HUA, isotype XAL). Caquetá region, Aug. 30, 1990, **G. Parra & B. Echeverry 2** (HUA, XAL).

Discussion. The form and size of the pleurocystidia separate this species from ***P. wrightii*** Guzmán and ***P. brasiliensis*** Guzmán, the former only known from central Argentina and the second from the Sao Paulo Region in Brazil (Guzmán, 1983). These species including ***P. heliconiae*** belong to Sect. Cordispora.

Psilocybe subacutipilea Guzmán, Saldarriaga, Pineda, García et Velázquez, sp. nov. Figs. 10-14

Differt Psilocybe acutipilea (Speg.) Guzmán cheilocystidia 13-20 x 3.5-6 μm et habito caespitoso. Basidiocarpia in pratis ad terram, in regione subtropicali. Colombia, prope Antioquia, Medellín-Amalfi, Porce, Puente Gabino, Guzmán 29561-B, holotypus Herb. HUA; isotypus Herb. XAL.

Pileus 7-10 mm in diam., campanulate to subumbonate, subviscid to lubricous, glabrous, even to striate, hygrophanous, yellowish brown, grayish yellow to pale brownish. Lamellae subadnate, somewhat thick, grayish brown with violaceous tinges. Stipe 40-50 x 1-1.5 mm, cylindric, subbulbous, whitish yellow, smooth to floccose toward the base, without pseudorhiza. Context of the pileus whitish, thin. Odor and taste farinaceous. All the basidiomata turning blue-green when cut or bruised. KOH stains the pileus dark grayish brown, the stipe vinaceous brown and is negative in the context.



Figs. 10-17. Two species of *Psilocybe*, 10-14: *P. subacutipilea*, 10: basidiomata, 11: spores, 12: cheilocystidia, 13: basidia, 14: context hyphae. 15-17: *P. heliconiae*, 15: basidiomata, 16: spores, 17: pleurocystidia (all from the type). Scale bar =10 mm in 10 and 15, =10 μm otherwise.

Spores (7.5-) 8.5-9 (-11) x 5-6 (-7) μm, slightly subrhomboid in face view, subellipsoid in side view, with a thick yellowish brown wall and with a broad germ pore. Basidia 22-32 x 8-10 μm, 2-, 3- or 4-spored, hyaline, ventricose to subpiriform. Pleurocystidia absent. Cheilocystidia 13-20 x 3.5-6 μm, hyaline, vesiculose to sublageniform with a short neck less 8 μm long, sometimes irregular in form with a short lateral neck, abundant but the gill edge is heteromorphous and thick. Epicutis a gelatinous layer 25-30 μm thick, with irregular hyphae in diameter, 5-15 μm wide. Hypodermium with parallel hyphae, 2-9 μm in diam. Context of the pileus with subglobose elements, thick-walled (1-1.5 μm thick), with brown incrusted pigment. Gill trama parallel, hyphae irregular in diameter, hyaline or with brown pigment incrusted on the wall. Clamp connections present.

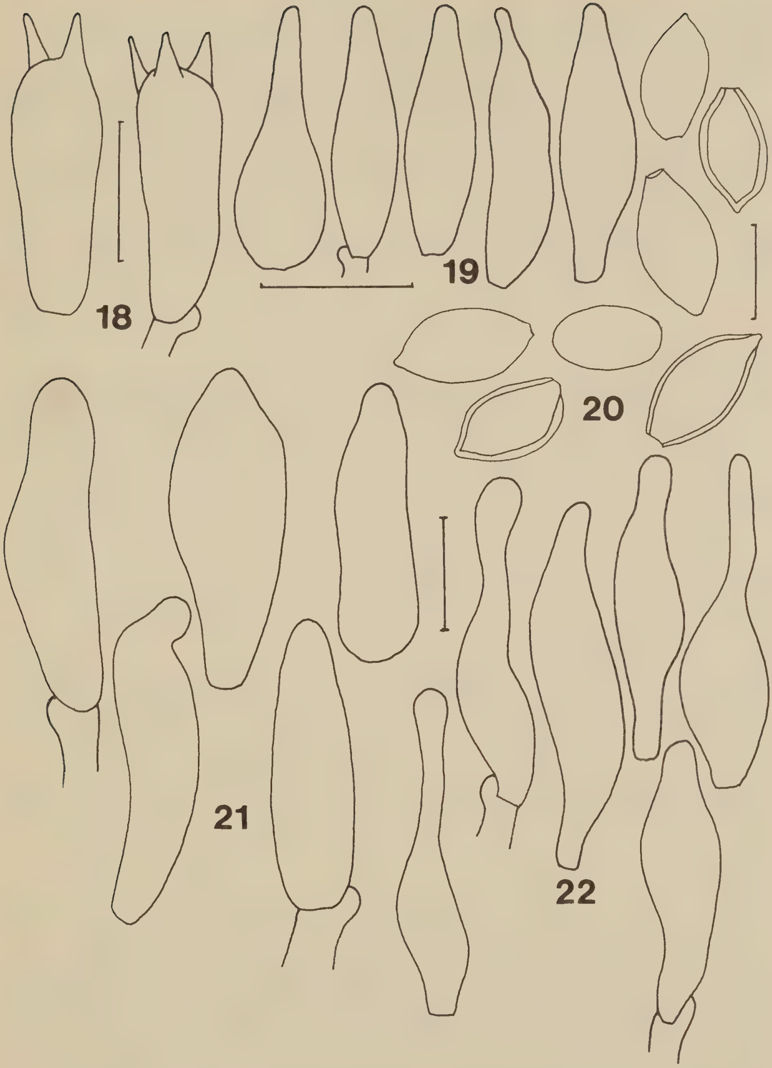
Habitat and distribution. Caespitose in soil, in a meadow with grazing grasses, in subtropical zone, at 1100 m alt. Known only from the type locality.

Studied material. COLOMBIA, Departamento Antioquia, Municipio Porce, near the road Medellín to Amalfi, zone of Puente Gabino, Aug. 31, 1990, **Guzmán 29561-B** (holotype HUA, isotype XAL).

Discussion. This species is close to ***P. acutipilea*** (Speg.) Guzmán known only from Brazil, of which it differs by the not papillate pileus and not caespitose habit and by the neck of the cheilocystidia (8-10 μm long) (Guzmán, 1983). *P. subacutipilea* belongs to Sect. Mexicana.

THE KNOWN SPECIES OF *PSILOCYBE* FROM COLOMBIA

Guzmán (1978, 1983), Guzmán and Varela (1978), Pulido (1983), Saldarriaga *et al.* (1988) and Velázquez *et al.* (1989) reported 13 species of ***Psilocybe*** from Colombia. Adding the four species described in the present paper, it makes a total of 17 taxa for Colombia (table 1). Ten of these species are hallucinogenic but are not used for ceremonial purposes by the ethnic groups, which is in contrast to the situation in Mexico (Guzmán, 1984). However, Schultes and Bright (1979) supposed that the Colombian Indians once used the hallucinogenic mushrooms, according to Indian gold pectorals and gold figures found in precolombian sites in Colombia, that resemble mushrooms and probably indicate the use of the sacred mushrooms.



Figs. 18-22. Two species of *Psilocybe*, 18-19: *P. heliconiae*, 18: basidia, 19: cheilocystidia (both from the type). 20-22: *P. cubensis*, 20: spores, 21, pleurocystidia, 22: cheilocystidia (from Guzmán 29568-B). Scale bar =10 μm.

Table 1. The known species of ***Psilocybe*** in Colombia, including the four new species described here

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* *P.* ***antioquensis*** Guzmán, Saldarriaga, Pineda, García & Velázquez
P. ***argentina*** (Speg.) Singer (Guzmán, 1978; 1983; Guzmán & Varela, 1978; Pulido, 1983)
P. ***bullacea*** (Bull.: Fr.) Kummer (Guzmán, 1978; 1983; Guzmán & Varela, 1978)
P. ***castanella*** var. ***subhyperella*** (Singer) Guzmán (Singer, 1973; Guzmán, 1978; 1983)
* *P.* ***colombiana*** Guzmán (Guzmán, 1978, 1983; Guzmán & Varela, 1978; Pulido 1983)
P. ***coprophila*** (Bull. Fr.) Kummer (Guzmán, 1983; Pulido 1983)
* *P.* ***cubensis*** (Earle) Singer (Guzmán, 1983; Pulido, 1983) (figs. 20-22)
P. ***fimicola*** Guzmán (Guzmán, 1978; 1983; Guzmán & Varela, 1978)
P. ***guatapensis*** Guzmán, Saldarriaga, Pineda, García & Velázquez
* *P.* ***heliconiae*** Guzmán, Saldarriaga, Pineda, García & Velázquez
P. ***montana*** (Pers.: Fr.) Kummer (Guzmán, 1978; 1983; Guzmán & Varela, 1978; Pulido, 1983)
P. ***phyllogena*** (Peck) Peck (Guzmán, 1983; Pulido, 1983)
* *P.* ***pintonii*** Guzmán (Guzmán, 1978, 1983; Guzmán & Varela, 1978; Pulido, 1983)
* *P.* ***subacutipilea*** Guzmán, Saldarriaga, Pineda, García & Velázquez
* *P.* ***subcubensis*** Guzmán (Guzmán, 1978, 1983; Guzmán & Varela, 1978; Saldarriaga *et al.*, 1988; Velázquez *et al.*, 1989)
* *P.* ***yungensis*** Singer & Smith (Guzmán, 1983)
* *P.* ***zapotecorum*** Heim emend. Guzmán (Guzmán, 1983; Pulido, 1983)

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* hallucinogenic species

Except ***P. fimicola*** that is a coprophilous fungus only known from a site in a páramo (Guzmán, 1983), ***Psilocybe argentina***, ***P. coprophila***, ***P. cubensis*** (figs. 20-22) and ***P. subcubensis*** seem to bee the most frequent ones in Colombia, due to their coprophilous habitat. *P. argentina* is known from high altitude (páramos) and the others from meadows in the regions subtropical and tropical. ***P. cubensis*** and ***P. subcubensis*** are used as recreation by young people at the Medellín region, where they are known as "hongo rey". So far ***P. colombiana***, ***P. pintonii***, ***P. fimicola*** and the four new species are known only from Colombia.

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PLUMIER'S "DISCOMYCETES"

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SUMMARY: *Peziza plumieri* Fr., based on a drawing by Plumier, is a synonym of *Hirneola nigricans* (Swartz) Donk, *P. speciosa* Fr. is an older name for *Cookeina sulcipes* (Berk.) Kunze.

Since 1910 the nomenclature of fungi, apart from a few specialised groups, has taken as its starting point the three volumes of Fries' Systema Mycologicum with their associated volumes entitled Elenchus fungorum 1 and 2. Until recently all other names of fungi published before 1st January 1821 were permanently devalidated. There was thus a strong inducement for taxonomists to understand the taxa published in the volumes of the Systema and adopt wherever possible a specific epithet published in them since it was immune from possible replacement under the principle of priority.

Type specimens seldom survive for these old names, especially those of perishable fungi. As a rule, Fries was compiling names earlier proposed by other authors and the best that can be hoped for in the form of a type is a recognisable published figure cited by the founder of the species. Among the names in this category are those of two species referred by Fries to *Peziza* in the second volume of the Systema, 1822, namely *P. plumieri* Fr. and *P. speciosa* Fr., both based on drawings published by the prelinnaean author Charles Plumier. Saccardo transferred both names to *Lachnea*, effectively eliminating the second by printing it as a subspecies of the first, but neither seems to have been recognised in nature since Plumier's day.

Plumier was a Minim, a member of the austere order of St Francisco di Paola stationed in the French West Indian colonies during the reign of Louis XIV but also recognised as Royal Botanist in the West Indies and author of a folio volume of drawings and descriptions of American ferns printed by the Royal Printing Press at Paris in 1705, hence at least tacitly with the approval of le Roi-soleil himself. Towards the end of the volume are two pages of line drawings of fungi, accompanied by phrase names in French and Latin but no additional data, all apparently natural size. No localities are given for the fungi but it is reasonable to assume that they came from the same places as the ferns, of which 97 were from Saint Domingue, ie Haiti, 66 from Martinique, 15 from both islands and 1 from St Vincent. Hence it was somewhat disingenuous of Singer (1945) to reject *Boletus coccineus* Fr., based on Plumier's Tab.176A largely on the ground that "All we know is that it was found somewhere in America"; a better reason would have been that Fries proposed the name in subspecific rank. Singer dismissed Plumier's illustrations as "somewhat fantastic pictures in black and white" but in fact, though he certainly was not an inspired artist, most of his figures are readily recognisable by anyone familiar with West Indian fungi. Dring (1980) gave a juster and less prejudiced assessment when he remarked of Plumier's figure of *Clathrus crispus* that "The oldest drawing by Plumier gives a much better idea of the normal shape of the receptacle than does the type figure based on a sketch by Poiteau". As will be seen, the two "*Peziza*" or "*Lachnea*" species based on Plumier's drawings are also readily recognisable; they have been overlooked because Fries was not familiar with the West Indian mycota and thus failed to understand the nature of *P. plumieri*.

Peziza plumieri Fr. was based on Plumier's Tab.168 Fig. E which is captioned: Fungoides scutellatum purpureum, deforis villosum. Fungoide en forme d'écuelle coulure de poupre, & velu au dehors. Fries expanded the diagnosis to Magna, sessilis, hemisphaerica, purpurea extus sericeo-villosa and compared it with *P. hemisphaerica* Wigg. "sed multo major uncialis & ultra". The figure gives two views of cupshaped carpophores respectively 37 and 39 mm diameter, at least 15 mm deep, sessile on a small base 9 or 10 mm wide, with thin flesh, smooth inner surface and a dense external coating of short downy hairs. As long as this was thought to represent a *Peziza* or a *Lachnea* it is not surprising it was never recognised again for no member of the Pezizales like this and purple in colour is known in the West Indies or any other part of the tropics. Clearly what Plumier drew was the very common pantropical fungus best known as *Auricularia (Hirneola) polytricha* (Mont.) Sacc. That this was referred to by Fries to *Peziza* need cause no surprise, even the common European *A. (H.) auricula-judae* was *Peziza auricula* for Linnaeus and all 18th century botanists up to Bulliard who called it *P. auricula-judae*. Fortunately it is not necessary to recombine *P. plumieri* in *Auricularia* or *Hirneola* because Donk (1952) has already found a name for our fungus in the Systema viz: *Hirneola nigricans* (Swartz) Donk based on *Peziza nigricans* Swartz: Fr. Syst. Myc. 2: 81 1822, the type of which was from Jamaica.

Purple may not be the colour which first springs to mind in describing this common fungus but perception and description of colour is a highly idiosyncratic matter and Montagne (1856) himself cited *Exidia purpurascens* Jung. as a synonym of his *H. polytricha*. Lowy (1952) cited as an additional "purple" synonym, "*Exidia porphyrea* Lév." but this was not accepted by Donk and is at least doubtful. Lowy does not say he had seen the type at Paris but apparently accepted the name in the interpretation by Teixeira (1945) based on material from Brazil. Teixeira's photographs of his fungus could well depict the same fungus as Plumier figured but he described the hymenium as blue, blackening at times, slate-blue when dried. Léveillé (1844) in the diagnosis cited by Lowy described *Exidia porphyra* as 'Pileo sessilis membranaceo concavo expanso rufo tomentosa hymenio glabro laevi porphyreo' and, as will be seen, the difference in spelling the specific epithet was deliberate and significant. Πορφυρα is the crimson dye extracted by the Phoenecians from gasteropods in the genera *Murex* and *Purpura* and, by extension, cloth coloured by it, so costly as to be reserved for the robes of oriental kings and Byzantine emperors, so much so that from the time of Constantine VII, whose cognomen it was, porphyrogenetos was the term applied to children born to an emperor after his accession, as being truly born in the purple. Probably also the colour of those "Lilies of the field" of which it was said "Solomon in all his glory was not arrayed like one of these". It is difficult to envisage a *Hirneola* that colour or that if such exists it can be reduced to a synonym of *H. nigricans*. However, in another place (Gaudichaud 1844) Léveillé made it plain he was not inspired by the vanished splendour of the Byzantine court, of Solomon or of Hiram, King of Tyre but was referring to the dingy vinous red of an alga: "L'hyménium est .... d'un rouge vineux qui rappelle l'*Ulva porphyra*". Thus the specific epithet is not an adjective but a noun in apposition and the change of spelling by Saccardo to *porphyrea* is wrong and actively misleading. Fries (1848) spelled the epithet *porphyra* and retained the species distinct from *H. polytricha* though he admitted there was considerable similarity. The figure of the type published in the Atlas to the voyage of the Bonite, under yet another name, *Tremella porphyra* Lév., does suggest a *Hirneola* but certainly does not evoke *H. nigricans*.

Peziza speciosa Fr., coccinea, cupula hemisphaerica ciliata, stipite unciali tuberoso was based on Plumier's Tab.168 Fig.C, captioned Fungoides cyathiforme coccineum, oris pilosis. Fungoide en maniére de verre couleur d'écarlate, à bord velu. The figure is of a group of three apothecia, not connate at the base, with cups 20-36 mm diameter, about 10-15 mm deep, stipes cylindric, 20-26 x 2-4 mm, smooth throughout apart from a marginal fringe of fine short hairs. They unmistakably depict the very common *Cookeina sulcipes* (Berk.) Kunze, characteristic of plantation debris in the West Indies and throughout the tropics. *P. speciosa* may have been overlooked not only because few practising mycologists had access to Plumier's work but because Saccardo printed the name, in *Lachnea*, as that of a subspecies of *L. plumieri*. That was ridiculous, the two fungi have nothing in common beyond the size of the cup. One is longstalked, scarlet, smooth throughout except at the extreme margin, the other sessile, purple, downy hairy all over. Saccardo may have been influenced by Fries' action in printing *P. speciosa* after *P. plumieri* and without a separate number but his comment compared it with *P. coccinea* Jacq. (*Sarcoscypha coccinea* (Fr.) Lambotte): "media videtur inter P. coccineam & sequentem tribum". The following "Tribe" was "Ciliares" and the absence of a number rather reflects his uncertainty just where to insert it in his sequence of species. *P. speciosa* is listed in the same way as other species of *Peziza* in the index to volume 3 of the Systema Mycologicum. The new combination *Cookeina speciosa* (Fr.) comb.nov. is therefore required, with basionym *Peziza speciosa* Fr. Systema Mycologicum 2: 84, 1822.

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KRETZSCHMARIELLA CULMORUM (COOKE) COMB. NOV. AND NOTES ON SOME OTHER MONOCOT-INHABITING XYLARIACEOUS FUNGI

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ABSTRACT

The genus *Kretzschmariella*, long considered a synonym of *Hypoxylon*, is reinstated to accommodate *H. culmorum* primarily on the basis of its unusual *Mirandina* anamorph. Some other monocot-inhabiting taxa that could be confused with *K. culmorum* are discussed.

Key words: Ascomycetes, bamboo, *Dactylaria*, *Hypoxylon*, *Kretzschmariella*, *Mirandina*, *Nummularia*, *Rosellinia*, *Sphaeria*, *Smilax*, Xylariaceae

Ju and Rogers (1990) described some cultural and developmental features of two species of *Astrocystis* Berk. & Broome, moving them into *Rosellinia* De Not. A major reason for this transfer, and the elimination of *Astrocystis*, was the thesis that many fungi of various affinities that have become inhabitants of bamboo have come to have similar stromatal characters owing in part to selection pressure exerted by the hard bamboo substrate (Ju and Rogers, 1990). In this paper we consider additional taxa from bamboo and other monocots with hard surfaces.

MATERIALS AND METHODS

Cultures originated from multiple ascospores. Subsequent cultures were derived from single ascospores in order to determine whether or not incompatibility factors were involved in production of teleomorphs. All colonies were grown on 2% Difco Oatmeal Agar (OMA). Teleomorphic stromata were produced when entire mature colonies were placed on fresh plates of SMEA, a formulation of malt agar (Kenerley and Rogers, 1976), and incubated for various periods of time.

Kretzschmariella Viégas

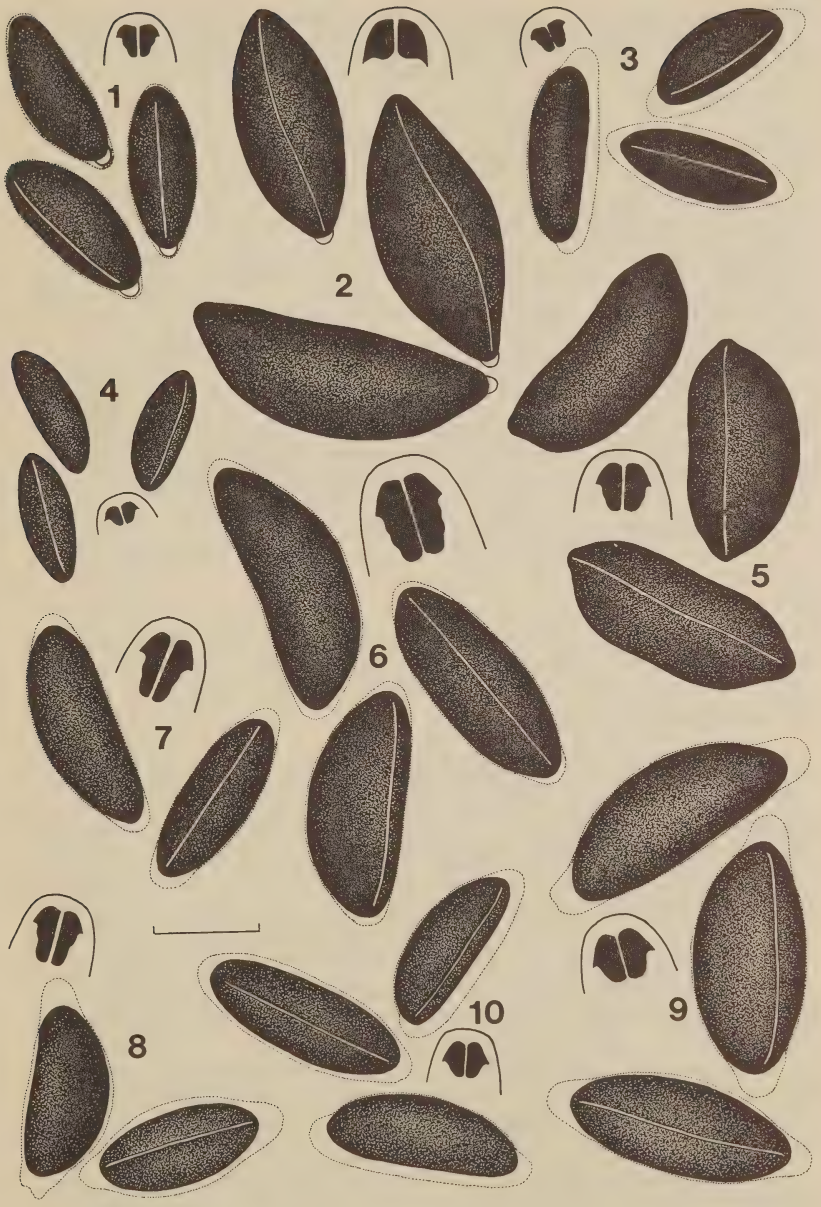
Kretzschmariella guaduae Viégas, the type species, was considered to be a synonym of *Hypoxylon culmorum* Cooke by Petrak (1951). This disposition was accepted by Miller (1961). Recent cultural data, including an anamorph that is unusual or perhaps unique among the Xylariaceae, compels us reinstate *Kretzschmariella*.

Kretzschmariella culmorum (Cooke) comb. nov. Figs. 1 & 11.
Basionym: ***Hypoxylon culmorum*** Cooke, Grevillea 7: 51. 1878.
= ***Kretzschmariella guaduae*** Viégas, Bragantia 4: 105. 1944.
? = ***Auerswaldia bambusicola*** Speg., Anal. Soc. Cient. Argent. 19: 246. 1885.
≡ ***Hypoxylon bambusicolum*** (Speg.) Speg., Anal. Soc. Cient. Argent. 26: 31. 1888.

Stromata effused-pulvinate, orbicular to elliptical, usually containing multiple perithecia, gregarious, superficial (probably subcuticularly erumpent), 1-5 mm long x 1-4 mm broad x 0.2-0.4 mm thick; surface gray at first, becoming black, plane to slightly undulate; outer crust thin, black, carbonous; interperithecial tissue whitish, soft, becoming brownish, disintegrated when aged; tissue lacking below the perithecial layer. Perithecia flattened-spherical, 0.2-0.3 mm diam x 0.1-0.2 mm high. Ostioles faintly papillate. Asci eight-spored, cylindrical, uniseriate, short-stipitate, 90-100 μm total length x 9.5-14 μm broad, the spore-bearing part 84-93 μm long, with apical ring bluing in Melzer's reagent, inverted hat-shaped, 3-4.5 μm diam x 2.5-4 μm high. Ascospores brown to dark brown, unicellular, ellipsoid-inequilateral, smooth, with narrowly rounded ends, 13-17.5 x 5-7.5 μm, with straight germ slit slightly less than spore-length to spore-length on the flattened side, usually bearing a cellular appendage on immature ascospores and sometimes on mature ascospores, with hyaline sheath closely appressed to the ascospore proper.

Colonies on OMA at ca. 20 C and under 12 h fluorescent light covering 9 cm Petri dish in 4 wk, appressed, azonate, with diffuse margins, white at first, becoming gray when reaching the edge, usually sectored into areas with differing conidial-producing activity. Exudate hyaline. Reverse uncolored. Stromata scattered, pulvinate, orbicular, gray. Teleomorph produced in 4 months after entire colony transferred to SMEA and serially to SMEA several times, homothallic, with morphological features as described above. Conidium-bearing regions over entire surface, olivaceous, finely granular. Conidiophores scattered or aggregated into pustules, unbranched to dichotomously branched, hyaline, smooth, slightly constricted at septa, 4-5 μm broad. Conidiogenous cells hyaline, smooth, 6-20 x 4.5-7 μm, terminal, indeterminate, with discoid conidial secession scars 1-1.5 μm high x 1.5-3 μm broad. Conidia produced holoblastically in sympodial sequence.

Figs. 1-10. Ascus tips and ascospores. 1. ***Kretzschmariella culmorum*** from the type. 2. ***Hypoxylon bambusicolum*** var. ***chusqueae*** from the type. 3. ***Hypoxylon chusqueae*** from the type. 4. ***Nummularia minutula*** from the type. 5. ***Hypoxylon nummularioides***, from the type of ***Nummularia reyesiana***. 6-8. ***Rosellinia sublimbata***. 6. from Candoussau 121. 7. from Sivanesan et al. 8. from Vivant 5281. 9. ***Rosellinia dimidiata*** from the type. 10. ***Sphaeria smilacicola*** from the type of ***Hypoxylon smilacicolum*** E. Howe. The scale marker represents 10 μm.



Conidia pale brown, usually multicellular, beaked, cylindrical, 60-170 x 6-8 μm, sometimes one- to several-celled, unbeaked, ellipsoid to oblong-obovate, 8-40 x 4.5-7 μm, with truncate base 1.5-3 μm broad indicating former point of attachment to conidiogenous cell.

SPECIMENS EXAMINED: BRAZIL: Sao Paulo, Mata, Serrada Cantareira, 2.XI.1935, Krug, H.P. 1281, culm of ***Guadua*** (W: TYPE of ***Kretzschmariella guaduae***). GRENADA: Grand Etang, 1912-13, Thaxter, R. 6871-a, culm of bamboo, as ***Hypoxylon culmorum*** by Miller, J.H. (GAM 2231); Grand Etang, 1912-13, Thaxter, R. 6907, culm of bamboo, growing together with ***Rosellinia sublimbata***, as ***Hypoxylon culmorum*** var. nov. in herb. by Miller, J.H. (FH; JDR), as ***Hypoxylon nummularioides*** Rehm var. ***microspora*** Miller in herb. by Miller, J.H. (GAM 2232). GUADELOUPE: Morne à Louis Route de la Traversée, 1.XI.1992, Vivant, J., sent by Candoussau, F. as 5281 (CULTURED), culm of bamboo, growing together with ***Rosellinia sublimbata*** (JDR). PARAGUAY: Carapegua, 24.VII.1883, Balansa, B. 4036, culm of bamboo, growing together with ***Rosellinia sublimbata***, as ***Hypoxylon bambusicolum*** by Spegazzini, C. (BPI). U.S.A.: Georgia, Darien, Ravenel, H.W. 2505, culm of ***Arundinaria*** (K: HOLOTYPE of ***Hypoxylon culmorum***); Georgia, Darien, Ravenel, H.W. 351, culm of ***Arundinaria***, as ***Hypoxylon culmorum*** (K).

The following specimens may belong here. However, their identity can not be definitely established due to their depauperate condition.

SPECIMENS EXAMINED: BRAZIL: Vicosa Escola, 9.VI.1934, Muller, A.S., culm of ***Merostachys speciosa*** by Miller, J.H. (GAM 2230). PUERTO RICO: 1927, Muller, A.S., culm of bamboo, as ***Hypoxylon culmorum*** by Miller, J.H. (GAM 2236 & 2237).

NOTES: For the present, ***Kretzschmariella*** includes only ***K. culmorum*** based primarily on its anamorph. Large multicellular conidia have not been previously reported in the Xylariaceae, to our knowledge. This anamorph is very similar, if not identical, to ***Mirandina dactylelloides*** T. Matsushima which has been reported twice on bamboos from Taiwan and Cuba by Matsushima (1980, 1987). Hoog (1985) considered ***Mirandina*** G. Arnaud ex T. Matsushima to be a synonym of ***Dactylaria*** Sacc. Owing to the uncertain taxonomic position of ***M. dactylelloides***, however, a formal redisposition into ***Dactylaria*** was not made (Hoog, 1985). Samuels et al. (1987) have reported a somewhat similar anamorph under the hyphomycetous genus ***Ceratosporium*** Schwein. for ***Iodosphaeria*** Samuels, E. Müller & Petrini, a genus with apparent xylariaceous affinities. The teleomorph of ***K. culmorum*** is morphologically different from other bambusicolous xylariaceous fungi discussed in this work mainly in its possession of a cellular appendage in some mature ascospores. The exception is ***Hypoxylon bambusicolum*** var. ***chusqueae*** Pat. which also has a cellular appendage but lacks the hyaline sheath.

Hypoxylon bambusicolum was synonymized with ***H. culmorum*** by Shear (1945) and Miller (1961). We have not studied the type of ***H. bambusicolum***, which is at PC (Shear, 1945), but have examined authentic material of Spegazzini at BPI. The synonymy will not firmly be established until the PC type is studied.

OTHER BAMBUSICOLOUS XYLARIACEOUS FUNGI OF UNCERTAIN POSITION EASILY CONFUSED WITH OR RELATED TO *KRETZSCHMARIELLA CULMORUM*

These taxa are listed alphabetically by their species epithets.

Hypoxylon bambusicolum (Speg.) Speg. var. ***chusqueae*** Pat., Bull. Soc. Mycol. France 11:223. 1895. Fig. 2.

Morphology of stromata and ostioles is as that of ***K. culmorum***. Perithecia flattened-spherical, 0.4-0.5 mm diam x 0.3-0.4 mm high. Asci eight-spored, cylindrical, uniseriate, extremely short-stipitate, 125-155 μm total length x 12 μm broad, with apical ring bluing in Melzer's reagent, dome-shaped, 5.5-6 μm diam x 3.5-5 μm high. Ascospores brown to dark brown, unicellular, ellipsoid-inequilateral, smooth, with narrowly rounded ends, 22-29 x 9.5-11.5 μm, with straight to slightly sigmoid germ slit nearly spore-length, bearing a cellular appendage on immature ascospores and sometimes on mature ascospores, without hyaline sheath.

SPECIMEN EXAMINED: ECUADOR: San Jorge, VII.1892, de Lagerheim, G., culm of ***Chusquea***, as ***Hypoxylon chusqueae*** Pat. in herb. by Patouillard, N. (FH: LECTOTYPE of ***Hypoxylon bambusicolum*** var. ***chusqueae***).

NOTES: No material labelled as '***Hypoxylon bambusicolum*** var. ***chusqueae*** Pat.' was found at the Patouillard herbarium of FH but three packets labelled as '***Hypoxylon chusqueae*** Pat.' were examined. One packet with Patouillard's pencil sketching on the envelop fits well the protologue, and is accordingly selected as the lectotype. The taxonomic status of this fungus will remain obscure until further data can be obtained. Its dome-shaped ascal apical ring is unusual among undoubted Xylariaceae, but commonly encountered in ***Amphisphaeria*** Ces. & De Not., ***Cainia*** Arx & E. Müller and ***Seynesia*** Sacc., genera that have often been placed in Family Amphisphaeriaceae. Miller (1961) suspected that the present fungus might be the same as ***H. nummularioides*** Rehm. The morphologies of apical rings, ascospores and the stromatic surface make a distinction between ***H. bambusicolum*** var. ***chusqueae*** and ***H. nummularioides*** clear (see later herein).

Hypoxylon chusqueae Henn., Hedwigia 39: 138. 1900; as '***chuesqueae***'. Fig. 3.

Stromata are frequently hypoxyloid, sometimes rosellinioid, otherwise as in ***Kretzschmariella culmorum***. Perithecia, ostioles and asci are as in ***K. culmorum***. Ascospores brown to dark brown, unicellular, ellipsoid-inequilateral, smooth, with narrowly rounded ends, 12.5-18 (-19) x 5-7 μm, with straight germ slit slightly less than spore-length to spore-length on the flattened side, without cellular appendage on mature ascospores, with hyaline sheath closely appressed to the ascospore proper on the convex side but remaining loose on both ends and the flattened side.

SPECIMENS EXAMINED: BRAZIL: Mattogrosso, 30.IV.1899, Pilger, culm of ***Chusquea*** (S: TYPE of ***Hypoxylon chusqueae***). ECUADOR: San Jorge, VII.1892, de Lagerheim, G., culm of ***Chusquea***, as ***Hypoxylon chusqueae*** Pat. in herb. by Patouillard, N. (FH). U.S.A.: Georgia, Morgan Co., swamp near Madison, 8.I.1927, Miller, J.H., culm of ***Arundinaria tecta***, as ***Hypoxylon culmorum*** by Miller, J.H. (GAM 2228).

NOTES: The type material from Brazil yields ascospores 12.5-16 x 5-6 μm, smaller than those of the American and Ecuadorian materials, 16-18.5 x 6-7 μm and 15-18 (-19) x 5-7 μm, respectively.

Petrini (1993) excluded ***Rosellinia pseudohypoxylon*** Speg. from ***Rosellinia*** and referred it to ***Hypoxylon***. The type was collected from Chile on ***Chusquea cummingi***. We have not seen the type, but suspect that it may be closely related to, or even conspecific with, ***H. chusqueae*** Henn.

Nummularia minutula Penz. & Sacc., Malpighia 11: 495. 1897. Figs. 4 & 12.
≡ ***Hypoxylon minutulum*** (Penz. & Sacc.) J. H. Miller ex S. Teng, A Contribution to Our Knowledge of the Higher Fungi of China, p. 125. 1939.

Stromata effused-pulvinate, orbicular to oblong elliptical, usually containing multiple perithecia, 0.8-15 mm long x 0.8-5 mm broad x 0.2-0.3 mm thick; surface black, plane; outer crust thin, black, carbonous; interperithecial tissue whitish to grayish, soft, disintegrated when aged; the tissue below the perithecial layer scanty or lacking. Perithecia spherical to oval, 0.1-0.2 mm diam. Ostioles faintly papillate. Asci eight-spored, cylindrical, uniseriate or with spores arranged in a partially biseriate manner, extremely short-stipitate (almost sessile), 65-77 μm total length x 7-10 μm broad, with apical ring bluing in Melzer's iodine reagent, inverted hat-shaped to short cuneate, ca. 1.5 μm high x 2.5-3 μm broad. Ascospores brown, unicellular, oblong ellipsoid-inequilateral to fusoid, smooth, with narrowly rounded ends, 10.5-13 (-14) x 4-5 (-5.5) μm, with straight germ slit slightly less than spore-length on the flattened side, with a cellular appendage on immature ascospores but not on mature ascospores, without hyaline sheath.

Colonies on OMA at ca. 20 C and under 12 h fluorescent light covering 9 cm Petri dish in 4 wk, velvety, appressed, azonate, with diffuse margins, brownish at first, becoming overlain with pinkish, felty hyphae from center outwards. Reverse uncolored to pale gray. Stromata scattered, but usually densely aggregated at periphery, applanate to pulvinate, orbicular to irregular, often becoming coalescent, black. Teleomorph produced in 2 months after entire colony transferred to SMEA one time, homothallic, with morphological features as described above.

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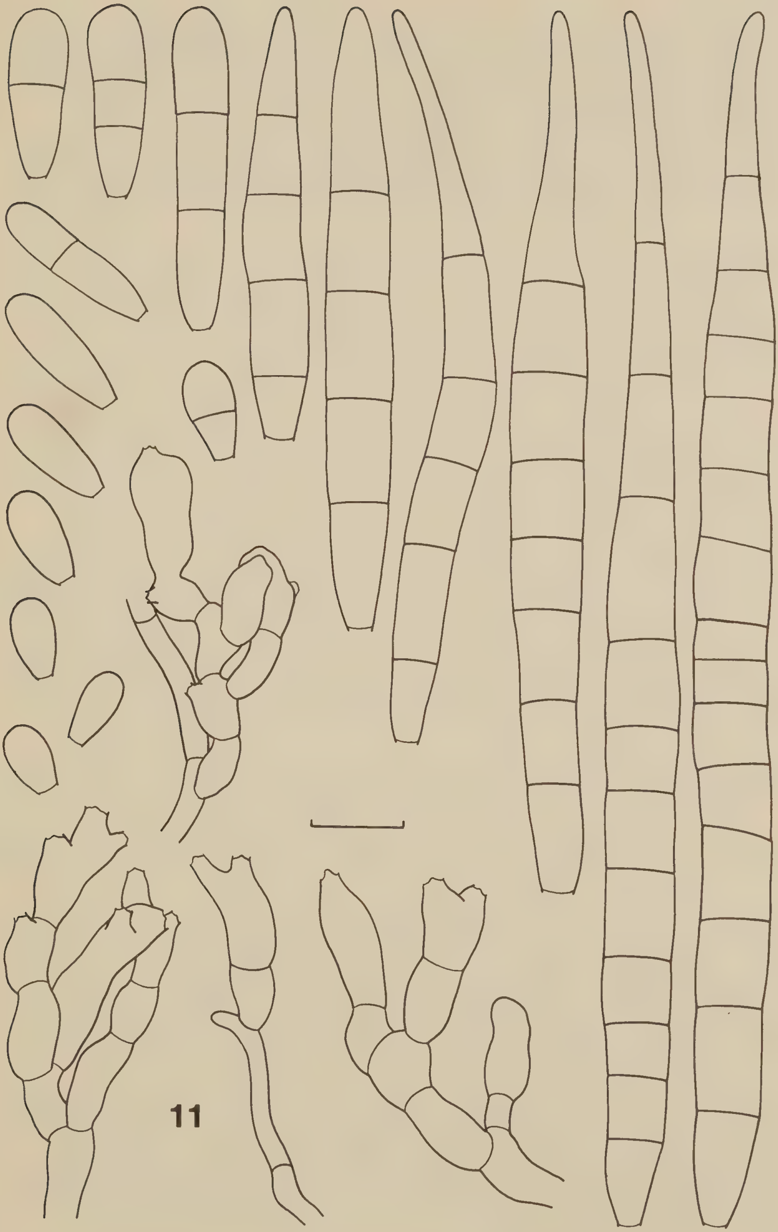
*Fig. 11. **Kretzschmariella culmorum***. Conidiophores and conidia from culture of Vivant 5281. The scale marker represents 10 μm.



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Conidium-bearing regions mostly restricted to center of colonies. Conidiophores in upright dense palisades, sinuous, di- or trichotomously branched 3-4 times from bases, brownish, smooth, sometimes ornamented with dark brown excrescences. Conidiogenous cells hyaline, smooth, cylindrical, 10-25 x 3-4 μm, terminal, indeterminate, with lateral and terminal discoid conidial secession scars 1 μm diam x 1 μm high. Conidia produced holoblastically in sympodial sequence. Conidia hyaline, smooth, ellipsoid to short cylindrical, 4.5-6 x 2-2.5 μm, with flattened bases 1-1.5 μm broad indicating former points of attachment to conidiogenous cell.

SPECIMENS EXAMINED: INDONESIA: Java, Tjibodas, 3.III.1897, no. 404, culm of ***Bambusa*** (PAD: HOLOTYPE of ***Nummularia minutula***). TAIWAN: Taipei City, Nei-hoo, 15.III.1988, Ju, Y.-M. 77031506 (CULTURED), culm of bamboo, growing together with ***Rosellinia bambusae*** (JDR).

NOTES: Ou (1936) and Teng (1939, 1964) had reported this fungus in China.
Nummularia Tul. & C. Tul. is a later homonym of the angiospermous genus of ***Nummularia*** Hill and, thus, should not be applied to any fungus. The fungus clearly is not a member of ***Biscogniauxia*** O. Kuntze or ***Camillea*** Fr., the genera used to accommodate most former ***Nummularia*** species, in lacking a dehiscent outer stromatic layer and in the morphology of the anamorph. The anamorph forms a dense palisade of conidiophores reminiscent of anamorphic ***Ustulina deusta*** (Hoffm.: Fr.) Petrak. The coarsely geniculated conidiogenous cells resemble those of certain members of the ***Hypoxylon serpens*** (Pers.: Fr.) Kickx complex. Because of its anamorphic features and multiple perithecia in a characteristic stroma it could probably be assigned to ***Nemania*** S. F. Gray. We prefer to withhold a formal disposition until the limits of ***Nemania*** are circumscribed.

Hypoxylon nummularioides Rehm, Leafl. Philipp. Bot. 6: 2272. 1914. Fig. 5.
= ***Nummularia reyesiana*** Rehm, Leafl. Philipp. Bot. 8: 2960. 1916.
≡ ***Hypoxylon reyesianum*** (Rehm) J. H. Miller ex S. Teng, A Contribution to Our Knowledge of the Higher Fungi of China, p. 125. 1939.

The general morphology is as described in Miller (1961). Asci with apical ring bluing in Melzer's reagent, inverted hat-shaped, 4.5-5 μm diam x 4.5-5 μm high. Ascospores brown to dark brown, unicellular, ellipsoid-inequilateral, navicular in profile, smooth, with narrowly rounded to pinched ends, 19.5-25.5 x 9-10.5 μm, with straight germ slit spore-length, without cellular appendage and hyaline sheath.

SPECIMENS EXAMINED: CHINA: Hainan, Yen-hsien, 1934, Deng, S.Q. 3586, culm of bamboo, as ***Nummularia reyesiana*** cited in Ou (1936), as ***Hypoxylon nummularioides*** by Miller, J.H. (GAM 12823). PHILIPPINES: Los Baños, 20.X.1913, Reyes, S.A. 1906, culm of ***Bambusa vulgaris*** (S: HOLOTYPE of ***Nummularia reyesiana***).

NOTES: ***Hypoxylon nummularioides*** and ***Nummularia reyesiana*** are considered as synonyms in Miller (1961). We were unable to examine the type of ***H. nummularioides*** at S which has been out on loan during the time we conducted this study.

This fungus is separable from ***Kretzschmariella culmorum*** by the reticulate cracks on the stromatic surface and by the larger boat-shaped ascospores that lack a cellular appendage and a hyaline sheath. It is not possible to reassign this fungus to another genus owing to lack of cultural and anamorphic data.

Rosellinia sublimbata (Durieu & Mont.) Pass. apud Thüm., Contr. Fl. Lusit. 2: 33. 1879. Figs. 6-8, 13.
≡ ***Sphaeria sublimbata*** Durieu & Mont., Fl. Alg. Crypt. I, p. 498. 1846-49.
≡ ***Astrocystis sublimbata*** (Durieu & Mont.) S. Hughes, Mycol. Pap. 50: 9. 1953.
≡ ***Hypoxylon sublimbatum*** (Durieu & Mont.) P. Martin, J. S. African Bot. 42: 74. 1976.
= ***Rosellinia amblystoma*** Berl. & F. Sacc., Rev. Mycol. 11: 118. 1889.
? = ***Rosellinia muroiana*** Hino & Katumoto, Bull. Fac. Agr. Yamaguti Univ. 9: 893. 1958.

For descriptions of stromata, perithecia, ostioles and asci, see Petrini (1993) for ***Rosellinia sublimbata*** and ***R. amblystoma***. Ascospores dark brown, unicellular, ellipsoid-inequilateral, smooth, with narrowly to broadly rounded ends, (13.5-) 14-22 x 6-9 μm, with straight germ slit slightly less than spore-length to spore-length, without cellular appendage on mature ascospores, with hyaline sheath closely appressed to the ascospore proper on the lateral sides but inconspicuous to conspicuous detached each end as noncellular appendages.

Colonies on OMA at ca. 20 C and under 12 h fluorescent light covering 9 cm Petri dish in 6 wk, felty to cottony, azonate, with diffuse margins, white. Reverse uncolored. Conidium-bearing regions sporadic on colonies. Conidiophores aggregated into loose pustules, sinuous, unbranched or dichotomously branched, hyaline to pale brown, smooth. Conidiogenous cells hyaline, smooth, terminal, cylindrical, 5-20 x 3.5-4.5 μm, with lateral and terminal discoid conidial secession scars 1-1.5 μm diam x 0.5-1 μm high. Conidia produced holoblastically in sympodial sequence. Conidia hyaline to pale olivaceous, smooth, ellipsoid, 4-5.5 x 2.5-3 μm, with flattened bases 1-1.5 μm broad indicating former points of attachment to conidiogenous cell.

SPECIMENS EXAMINED: ALGERIA: no. 36, culm of *Arundo mauritanica* (K:TYPE of *Sphaeria sublimbata*). BRAZIL: V.1896, Ule 2484a, culm of ***Chusquea***, as ***Hypoxylon chusqueae*** by Rehm, H. (S). CHINA: Chekiang Prov., Tien-mu-shan, 30.VI.1932, Teng, S.C. 1265, culm of ***Phyllostachys***, as ***Astrocystis mirabilis*** by Teng, S.C. (BPI); Kwangsi Prov., Yangso, 2.III.1938, Teng, S.C. 3071, culm of bamboo, as ***Astrocystis mirabilis*** by Teng, S.C. (BPI). FRANCE: Pyrénées Atlantiques, Sauveterre de Béarn, 23.III.1983, Candoussau, F. 121, culm of ***Phyllostachys bambusoides*** (JDR); near Mont de Marsan, 10.IV.1983, Vivant, J. & Candoussau, F., culm of *Sasa japonica* (JDR). MEXICO: Chiapas state, Ocosingo municipality, Ejido Boca de Chajul, 27.V.88, San Martín 777, culm of "caña brava" in the shore of Lacantún River (ITCV; JDR). Quintana Roo state, Othón P. Blanco municipality, Ejido La Unión, 12.XI.88, San Martín 1309, culm of "carrizo" in subevergreen tropical rain forest (ITCV; JDR). PHILIPPINES: Palawan, Lake Manguao, IV.1913, Merrill, E.D. 8964, culm of bamboo, as ***Hypoxylon culmorum*** by Sydow (GAM 2235). TAIWAN: Nan-tou Co., Lu-ku, Shi-tou, 22.VIII.87, Ju, Y.-M. 76082229 (CULTURED), culm of ***Phyllostachys pubescens*** var. ***pubescens*** (JDR; NTU); Taipei City, Young-ming-shan, 13.XII.87, Ju, Y.-M. 76121302, culm of bamboo (JDR; NTU); Kao-hsiung Co., Tien-chih, 28.I.88, Sivanesan, A. et al., culm of ***Yushania natakayamensis*** (JDR); Taipei City, Nei-hoo, 15.III.88, Ju, Y.-M. 77031506, culm of bamboo (JDR; NTU); Taipei Co., Wu-lai, 21.VI.88, Ju, Y.-M. 77062111, culm of bamboo (JDR; NTU).

The following specimens of ***Kretzschmariella culmorum*** are mixed with ***Rosellinia sublimbata***: GRENADA (Thaxter, R. 6907), GUADELOUPE (Vivant, J., sent by Candoussau, F. as 5281, CULTURED) and PARAGUAY (Balansa, B. 4036). See SPECIMENS EXAMINED of ***K. culmorum*** for detailed citation of these specimens.

NOTES: Petrini (1993) considered ***R. amblystoma*** and possibly ***R. muroiana***, which apparently has no extant type, to be synonymous with ***R. sublimbata*** as ***Astrocystis sublimbata***. She reported an ***Acanthodochium***-like anamorph from cultures of a collection from France. Material examined by us showed very inconspicuous to conspicuous hyaline sheaths and noncellular appendages. Cultures showed loosely aggregated conidiophores with conidia smaller than those reported by Petrini (1993), 4-5.5 x 2.5-3 vs. 5.5-8 x 3-3.5 μm. It is thus probable that ***R. sublimbata*** represents a complex of closely related species. In anamorphic characters, however, they are unlike ***Kretzschmariella culmorum***.

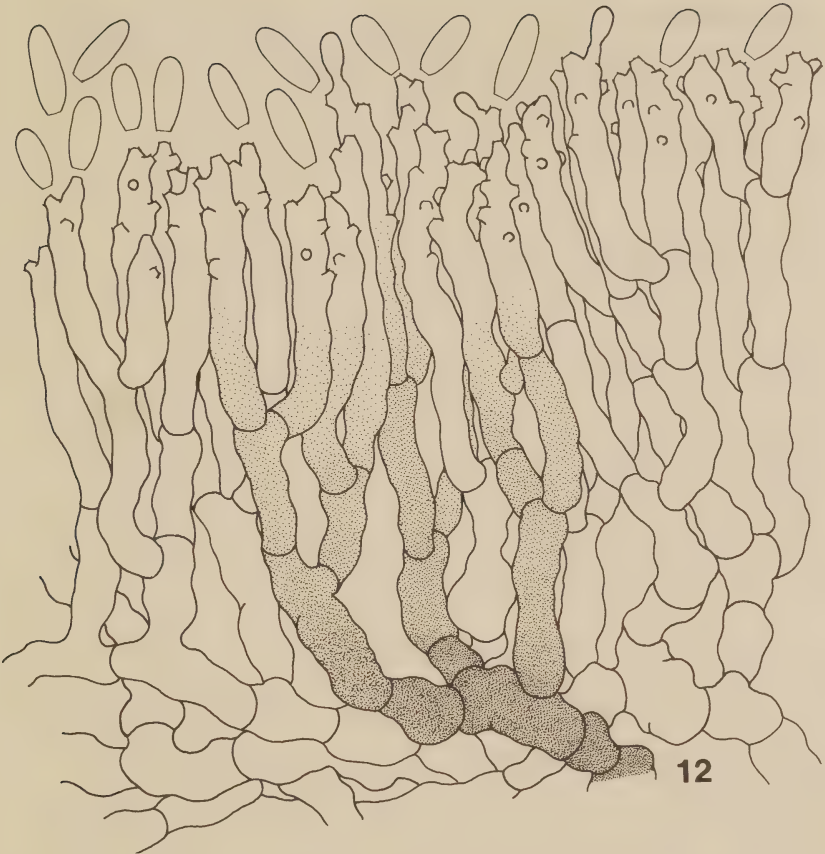
TWO XYLARIACEOUS FUNGI ON *SMILAX*

Rosellinia dimidiata Starb., Bihang Till K. Svenska Vet.-Akad. Handl. Band 25, Afd. III: 49. 1899. Fig. 9.

Teleomorphic morphology is as that of ***Rosellinia sublimbata***.

SPECIMENS EXAMINED: BRAZIL: Rio Grande do Sul, Cascata de Hermenegilda pr. Pelotas, 12.XI.1892, Malme, G.A. 105, stem of ***Smilax*** (S: HOLOTYPE of ***Rosellinia dimidiata***). LOCALITY UNKNOWN: 12.XII.1912, no. 985b, stem of ***Smilax***, as ***Hypoxylon smilacicolum*** Howe by Rehm, H. (S).

Figs. 12 & 13. Nummularia minutula and ***Rosellinia sublimbata***.
12. ***Nummularia minutula***. Conidiophores and conidia from culture of Ju 77031506.
13. ***Rosellinia sublimbata***. Conidiophores and conidia from culture of Vivant 5281.
The scale marker represents 10 μm.



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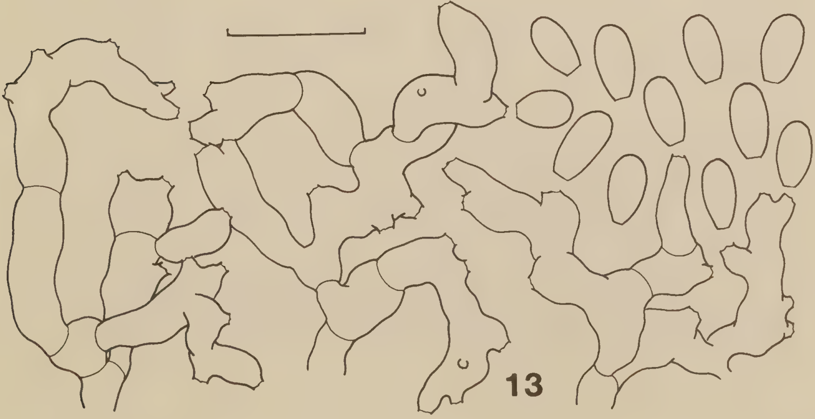

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NOTES: ***Rosellinia dimidiata*** seems morphologically very similar to ***R. sublimbata***. They are divided by the substrates on which they grow; the former is on ***Smilax***, whereas the latter is on bamboos. We have no inoculation or other data at present to assess the host specificity, or lack of host specificity, of this fungus.

Sphaeria smilacicola Schwein.: Fr. apud Fr., Elench. Fung. II, p. 71. 1828.
Fig. 10.

≡ ***Diatrype smilacicola*** (Schwein.: Fr.) Berk., Grevillea 4: 96. 1876.
= ***Hypoxylon smilacicolum*** E. Howe, Bull. Torr. Bot. Club. 6: 31. 1875.
? = ***Rosellinia smilacina*** Speg., Ann. Mus. Nac. Buenos Aires 19: 339. 1909.

Teleomorphic morphology is as that of ***Hypoxylon chusqueae***.

SPECIMENS EXAMINED: U.S.A.: New York, Yonkers, 1875, Howe, E.C., in 2 pks., stem of ***Smilax*** (NY: HOLOTYPE of ***Hypoxylon smilacicolum*** Howe); North Carolina, Salem, Syn. 1251 (mistakenly labelled as 1825), Collins coll. 99, stem of ***Smilax rotundifolia*** (PH: TYPE of ***Sphaeria smilacicola***); Pennsylvania, Gretna, Rorer, J.B. 6892, stem of ***Smilax***, as ***Hypoxylon smilacicolum*** Howe by Miller, J.H. (GAM 4258); Virginia, Great Falls, 27.X.1918, Kauffman, C.H., stem of ***Smilax rotundifolia***, as ***Hypoxylon smilacicolum*** (Schwein.) Howe by Shear, C.L. (GAM 4259 & 4260). LOCALITY UNKNOWN: 12.XII.1912, no. 985a, stem of ***Smilax***, as ***Hypoxylon smilacicolum*** Howe by Rehm, H. (S).

NOTES: ***Sphaeria smilacicola*** is the smilacicolous counterpart of ***Hypoxylon chusqueae***.

Fries (1828) first published ***Sphaeria smilacicola*** based upon Schweinitz's specimen which was collected from the stems of ***Smilax***. He credited Schweinitz as the author. Apparently not knowing that Fries had published, Schweinitz (1832) republished ***Sphaeria smilacicola*** in his Synopsis. However, he used the name twice for two different fungi. One, listed as no. 1251, was collected from the stems of ***Smilax*** in Salem, whereas the other, as no. 1825, was from the leaves of ***Smilax*** in Bethlehem. We have examined three packets of ***Sphaeria smilacicola*** from PH. The first one, no. 1825 from Bethlehem, contains a sterile fungus growing on a leaf; this is the ***Sphaeria smilacicola*** not listed in Fries' work. The second one, no. 1251 from Bethlehem, and the third one, a Collins collection as no. 1825 from Salem, contain the present fungus growing on stems of ***Smilax***. Since Schweinitz (1832) mentioned that the ***Sphaeria smilacicola*** growing on stems was collected in Salem, the third packet, Collins collection no. 99, should be accepted as the type material; it might have been mislabelled as no. 1825. Miller (1961) considered E. Howe to be the author of the species because he was the first to describe it as ***Hypoxylon***. This is an untenable decision.

It is possible that ***R. smilacina*** is a synonym, judging from Petrini's description and figures of type material (1993). This fungus has rosellinioid stromata, grows on ***Smilax***, and has ascospores highly similar to ***Sphaeria*** *smilacicola* and *H. chusqueae*. We suspect that *R. smilacina* represents an extreme rosellinioid form of *S. smilacicola*.

KEY TO TAXA DISCUSSED HEREIN

1. Ascospores without hyaline sheath 2
1. Ascospores with hyaline sheath 4

    2. Ascospores 10.5-13 (-14) x 4-5 (-5.5) μm.. *Nummularia minutula*
    2. Ascospores more than 18 μm in length 3

3. Ascal apical ring dome-shaped . *Hypoxylon bambusicolum* var. *chusqueae*
3. Ascal apical ring inverted hat-shaped . . . . . . *Hypoxylon nummularioides*

    4. Ascospores usually bearing a cellular appendage . . . . *Kretzschmariella culmorum*
    4. Ascospores not bearing a cellular appendage 5

5. Stromata usually hypoxyloid; ascospores with hyaline sheath tightly appressed to the ascospore proper on the convex side but remaining detached on the flattened side 6
5. Stromata usually rosellinioid; ascospores with hyaline sheath tightly appressed to the ascospore proper on both the convex and the flattened sides 7

    6. On bamboos . . . . *Hypoxylon chusqueae*
    6. On *Smilax* . . . . *Sphaeria smilacicola*

7. On bamboos . . . . *Rosellinia sublimbata*
7. On *Smilax* . . . . *Rosellinia dimidiata*

DISCUSSION

The anamorphic type that led us to reinstate *Kretzschmariella* was a surprising result of culturing. It is evident that some other fungi that look much like *K. culmorum* -- *Nummularia minutula* and *Rosellinia sublimbata* -- have anamorphs of the type usually expected in xylariaceous fungi. A number of these monocot-inhabiting fungi remain in untenable generic positions, e.g., *Hypoxylon* and *Nummularia*, because we have not cultured them and because we do not yet know the limits of alternative genera that might accommodate them. Moreover, we are uncertain whether more or less identical fungi on hosts as widely separated as

Smilax and the bamboos are to be regarded as conspecific. The present study is thus regrettably incomplete.

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A SCANNING ELECTRON MICROSCOPY STUDY OF **PHYTOPHTHORA** AND **HALOPHYTOPHTHORA** SPECIES[1]

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ABSTRACT

The morphology of hyphae, chlamydospores, sporangia and sex organs of 48 isolates representing 20 species of *Phytophthora* and 7 species of *Halophytophthora* available primarily from the American Type Culture Collection were studied with scanning electron microscope. The potential value of SEM in the taxonomic study of *Phytophthora* and *Halophytophthora* is reviewed and discussed.

INTRODUCTION

The genus *Phytophthora* in the family Pythiacae of the order Peronosporales is distinguished from other fungal genera by a number of unusual features, for example, the presence of glucans and cellulose in the cell wall instead of chitin, the requirement of exogenous supply of sterols for sporulation, the requirement of thiamine for vegetative growth, the complete differentiation of motile zoospores within the sporangium, and the formation of indeterminate sporangiophores with sporangia produced successively at the end of sympodial branches, the existence of both heterothallic and homothallic species and the production of oospores by crossing a heterothallic strain with appropriate mating type of the same or different heterothallic species.

To date, over 80 different species have been described and nearly all of them are plant pathogens of higher plants and their distribution is world wide. The taxonomy of *Phytophthora* has been notoriously difficult due to the extreme variability among and within species and the fact that a single host can be attacked by several different species causing similar disease symptoms. In recent years, new approaches including serological, biochemical, genetical, cytological and molecular investigations have been shown to be of great value in understanding the relationships among *Phytophthora* species. However, morphology still plays a key role in identifying species and provides the primary basis for the taxonomy of *Phytophthora*. Scanning electron microscope with its high resolution and great depth of field is becoming an extremely useful tool in the morphological study of fungi. SEM studies of *Phytophthora* species began with Desjardins *et al.* (1973), who used the instrument to confirm the light microscope observations of Ho *et al* .(1968), that the two flagella of a zoospore were inserted in a deep central groove running along the longitudinal axis of the zoospore. Honour (1973) used the same technique to show the granular to platy appearance of the pigmented oogonia of *P. parasitica*. Similarly, Ho and Zentymer (1977) re-examined the morphology of *P. cinnamomi* and Ho *et al.* (1977) demonstrated the bicellular antheridium and bullate papillae on the oogonial wall of *P. cambivora*. By a combination of SEM and TEM, Ho (1979b) re-studied the nature of amphigyny in a few selected species of *Phytophthora*. Ho (1979a) also demonstrated differences in the surface morphology of the oogonial wall of different *Phytophthora* species: smooth in *P. palmivora*, finely granular in *P. megasperma* var. *megasperma* and var. *sojae*, coarsely granular in *P. nicotianae* var. *parasitica*. Recently, Khan *et al.* (1988) observed distinct reticulate ridges on the surface of the sporangium and coarsely granular wall surface of chlamydospore in *P. nicotianae* var. *nicotianae* and suggested that SEM studies might prove useful in the diagnosis of *Phytophthora* species. The purpose of this research is to re-examine the *Phytophthora* species by SEM and determine the potential role of SEM in the taxonomic study of *Phytophthora*. For comparison, the marine species of *Phytophthora* (Stamps, *et al.* 1990) referred to as *Halophytophthora* by Ho and Jong (1990) were also investigated.

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[1] The research is based upon a dissertation submitted by Jie Pan to the Graduate School, State University of New York, New Paltz, in partial fulfillment of the requirement for the degree Master of Arts.

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MATERIALS AND METHODS

Isolates and media

Isolates of *Phytophthora* and *Halophytophthora* used in the study (Table1) were obtained from American Type Culture Collection (ATCC), Rockville, Maryland, except for *P.colocasiae* (OT1) which was received from Taiwan and *H. exoprolifera* which was received from Dr. Newell of the University of Georgia. Unless otherwise specified, isolates were cultured at 20° on clarified V8 agar medium(Ribeiro, 1978), supplemented with sterol (30mg/l). For the culture of marine species, "Instant Ocean" synthetic sea salt was dissolved in clarified V8 medium (1.5g/100ml) before autoclaving.

Sporangia production

Small discs (1.5 x 2.0 cm) were cut from the edge of a 3 to 4 days old mycelial colony and transferred to a 90 mm petri-dish containing millipore-filtered (0.45um pore size) stream water and left under fluorescent light. Sporangia were formed in 24 to 48 hours. For marine species, 1.5 artificial sea water was used (1.5g "Instant Ocean" synthetic sea salt dissolved in 100ml stream water before millipore filtration).

Sex organ production

Homothallic species were cultured in the dark for 1 to 5 weeks. They were checked regularly for sex organs by examination under a light microoscope. For heterothallic species of *Phytophthora* , an A1 and A2 inoculum discs were placed in the same agar plate, approximately 4cm from each other. The plates were incubated in the dark for 4 to 5 weeks. Sex organs were formed at the junction where the colonies met.

Scanning electron microscopy

(A) Semi-permanent slides

Agar discs (1.5 x 2.0cm) bearing sporangia and small agar strips (1 x 2cm) bearing mature sex organs were boiled in distilled water for 5 minutes to remove the agar. Small pieses of the mycelia were stained using 1% coton blue dye dissolved in lactophenol and mounted in clear lactophenol on glass slides for initial study with light microscope. The specimens later were removed from the slides and transferred through an ethanol series to remove the water, stain and lactophenol.

(B) Fresh cultures

Mycelial mats with sporangia and sex organs were fixed overnight in 2.5% glutaraldehyde in 0.2M sodium cacodylate buffer (pH 7.4), washed thoroughly with distiled water, dehydrated through an ethanol series and critical point dried. A small piece of the dried mycelium was spread on a double stick scotch tape mounted on a SEM aluminum specimen stub, sputter coated with gold/palladium and examined with an AMRAY 1830 scanning electron microscope at 15KV.

RESULTS

Hyphae

The hyphae of all *Phytophthora* species studied are consistently smooth as observed with the SEM (Fig. 1). Hyphal swellings are commonly found in *P. cinnamomi* (Fig. 2), but not in the other species.

Chlamydospore

Phytophthora cinnamomi, *P. nicotianae* and *P. palmivora* produce chlamydospores readily in culture. They are spherical, terminal or intercalary. In *P. nicotianae*, the chlamydospore is smooth-walled with inconspicuous reticulate markings on the surface (Fig. 3).

Sporangiophore

The sporangiophore of *Phytophthora* species is either simple or sympodially branched as shown in *P. cambivora* (Fig. 4).

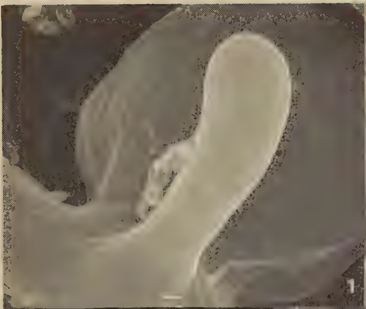
Sporangia

Sporangia of *Phytophthora* species vary in shape, ranging from ellipsoidal (Fig. 4), ovoid (Fig. 5), pyriform (Fig. 6), to limoniform (Fig. 7). The base of sporangia can be round as in *P. boehmeriae* (Fig. 8) and *P. cactorum* (Fig. 5), or tapered as in *P. botryosa*(Fig. 9) and *P. capsici*(Fig. 7). The sporangia of *P. colocasiae* (Figs. 10, 11) and *P. hibernalis* (Fig. 12) are long and narrow or elongated ellipsoidal, with the broadest part nearer the apex in *P. hibernalis*; the sporangia of *P. capsici* are often variable and irregular (Fig. 13). In most cases, the sporangium is terminal, borne on a sporangiophore which is similar but usually narrower than the hyphae. However, some sporangia are subterminal or intercalary with a hyphal projection attached to the side of the sporangium (Figs. 14-16). Zoospores are differentiated within the sporangium (Fig. 17) and released in a discharge vesicle (Fig. 18) which eventually ruptures with remnants attached to the edge of exit pore (Fig. 19). Sometimes, the sporangium germinates directly by one or more than one germ tubes near the apex (Figs. 20, 21).

Papillate sporangia are produced by *P. boehmeriae* (Figs. 6, 22), *P. botryosa* (Figs. 9, 23), *P. cactorum* (Fig. 5), *P. capsici* (Figs. 7, 24), *P. citrophthora* (Fig. 25), *P. heveae* (Fig. 26), *P. meadii* (Fig. 27, 28), *P. nicotianae* (Fig. 29) and *P. palmivora* (Fig. 30). When viewed under the SEM, the protruding hemispherical to convex apex is encircled by the surrounding sporangial wall forming a ring with a pronounced to shallow annular groove in-between. A sporangium of *P. cactorum*, broken at the distal end, shows an outer layer continuous over the apex and a inner layer underneath the apex (Fig. 31). Usually, the sporangium has only one apex but sometimes, the sporangia of *P. boehmeriae*, *P. capsici* and *P. nicotianae* are bipapillate (Fig. 32). Papillate sporangia are often caducous either with short, occluded stalks as in *P. boehmeriae* (Figs. 6, 8), *P. cactorum* (Fig. 5) and *P.megakarya*(Fig. 33), or with medium to long pedicel in *P. botryosa* (Fig. 9), *P. capsici* (Figs. 13, 24, 32, 34) and *P. meadii* (Fig. 27). The basal plug can be discerned within the pedicel (Fig. 33). Sometimes the basal septum is in the expanding part of the sporangium as in *P. meadii*(Fig. 35) and *P. nicotianae* (Fig. 36), forming a circular "scar" on the surface. Papillate sporangia are characterized by small exit pores, under 7 um in diameter (Fig. 33).

Semi-papillate sporangia are formed by *P. citricola* (Fig. 37), *P. colocasiae* (Figs. 10, 11), *P. hibernalis* (Fig. 12) and *P. infestans* (Figs. 38, 39). The papilla is either inconspicuously protruding as in *P. colocasiae*, *P. infestans* and *P. citricola* with a small exit pore (Fig. 10) or not noticeable at all in *P. hibernalis* (Fig. 12). The sporangia of *P. citricola* are non-deciduous whereas the pedicels of the deciduous sporangia are short in *P. infestans* and medium to long in *P. colocasiae* and *P.*

Figs. 1,2. Hyphae of *P. cinnamomi*. 1. Hyphal branch, 2. Hyphal swelling.
Fig. 3. Intercalary chlamydospore of *P. nicotianae* showing inconspicuous reticulate markings on the smooth surface.
Fig. 4. Ellipsoidal, non-papillate sporangium of *P. cambivora* with flattened sunken apex (Ap) and sympodial sporangiophore branch (Br) arising from the base of sporangium.
Fig. 5. Ovoid, papillate sporangium of *P. cactorum* showing the short stalk (S), round base (B) and protruding apex (Ap) surrounded by a ring.
Fig. 6. Pyriform, papillate sporangium of *P. boehmeriae* with round base (B), short stalk (S) and protruding apex (Ap) encircled by a ring.
Fig. 7. Limoniform, papillate sporangium of *P. capsici* with protruding papilla (P) and tapered base (B). Note the pedicel (Pd).
Fig. 8. Basal view of sporangium of *P. boehmeriae* showing the round base(B), short stalk(S). Scale bar = 1um in Fig. 1 while scale bar = 10um in others.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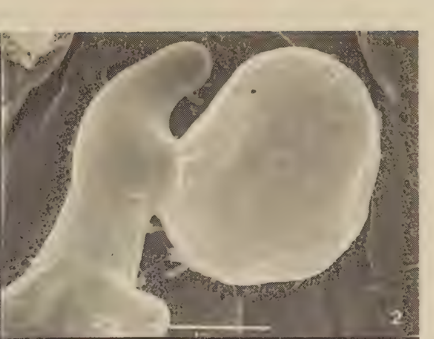
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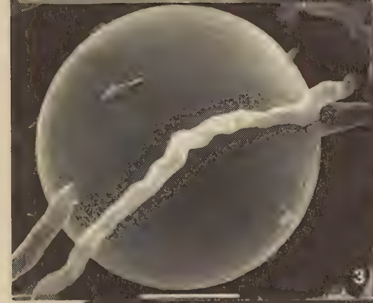
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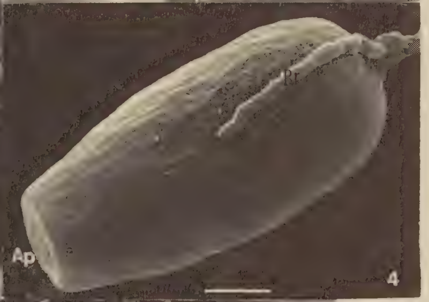
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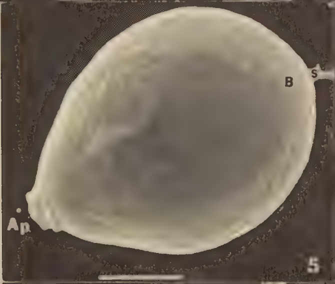
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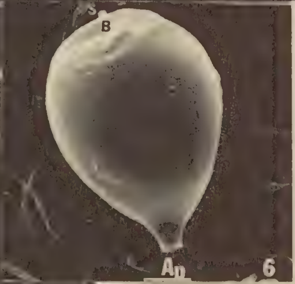
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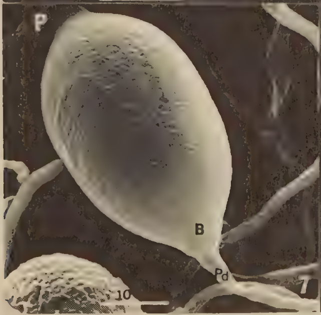
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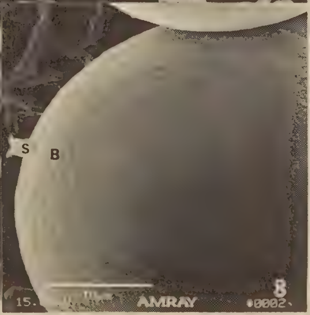
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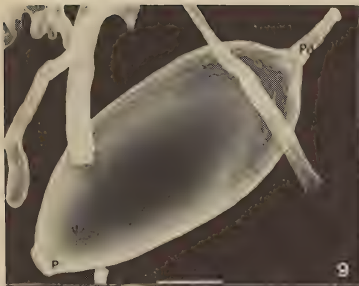
hibernalis. *Phytophthora hibernalis* also has conspicuously wider apex than the other three species . The non-papillate sporangia are found in *P. cinnamomi* (Figs. 40-42), *P. cambivora* (Fig. 4), *P. cryptogea* (Figs. 43, 44), *P. megasperma* (Fig. 45) and *P. richardiae* (Fig. 46). The sporangium has a wide flattened apex which is either concave, sunken with the tip flattened resembling the mouth of the volcano or slightly convex surrounded by the sporangial wall which appears as a circular ring (Figs. 41, 42, 44). A non-papillate sporangium is characterized by a wide exit pore (Fig. 45). The surface of the sporangial wall is either rough to granular in most species, for example, *P. cactorum* (Fig. 5), *P. heveae* (Fig. 25), *P. palmivora* (Fig. 16) and *P. megakarya* (Fig. 33) or smooth, inconspicuously striated as in *P. botryosa*, *P. cinnamomi* and *P. hibernalis* (Figs. 11, 25 and 40). On either form, there is no distinct ornamentation pattern.

In contrast to *Phytophthora*, the sporangia of *Halophytophthora* species are always non-deciduous with round base and often have conspicuous dehiscence tubes. The zoospores are released upon the ejection of a cylindrical, smooth plug from the dehisence tube (Figs. 47, 48). The sporangia of *H. epistomium* are ovoid or spherical with long dehiscence tubes (Figs. 47, 48) while the sporangia of *H. bahamensis* are pyriform with short dehiscence tubes (Fig. 49). *Halophytophthora exoprolifera* forms sporangia with or without dehiscence tubes (Figs. 50 and 51). The sporangium of *H. operculata* is unique in possessing an apical operculum. When zoospores are released, the sporangial apex is opened by a lid with one side attached to the exit pore (Fig. 52). The surface of sporangium is characteristically echinulate in *H. spinosa*, with spines randomly distributed in *H. spinosa* var.*lobata* (Fig. 53) but restricted to the distal end near the apex in *H. spinosa* var. *spinosa* (Fig. 54). *Halophytophthora batemanensis* (Fig. 55) and *H. vesicula* (Fig. 56) are similar in having rugulose sporangial surface but differ in having non-papillate apex in the former and protruding truncated apex in the latter.

Fig. 9. Papillate sporangium of *Phytophthora botryosa*. Note the medium pedicel (Pd), tapered base (B) and protruding papilla (P).
Figs. 10,11. Ellipsoidal, semi-papillate sporangia of *Phytophthora colocasiae*. Note the small exit pore (Ex), medium pedicel (Pd), rough sporangial surface and the slightly protruding apex (Ap) surrounded by a ring and a groove.
Fig. 12. Elongated ellipsoidal, semi-papillate sporangium of *Phytophthora hibernalis*. Note the wide non-protruding apex (Ap), tapered base (B), long pedicel (Pd) and the smooth surface.
Fig. 13. Papillate sporangium of *Phytophthora capsici*. Note the distorted shape with grossly elongated neck (N), the rough surface and protruding apex (Ap) with an annular ring.
Fig. 14. Intercalary, papillate sporangium of *Phytophthora heveae*. Note the suspending hyphae (H), protruding apex (Ap) surrounded by a ring and a groove.
Fig. 15. Intercalary, papillate sporangium of *Phytophthora nicotianae*. Note the basal hyphal appendeges (HA) and protruding apex (Ap) with annular ring and groove.
Fig. 16. Subterminal, papillate sporangium of *Phytophthora palmivora* showing the hyphal tip (HT), sporangiophore and protruding apex (Ap) with annular ring and groove.
Fig. 17. Differentiated zoospores (Z) within the ruptured sporangium (RS) of *H. exoprolifera*. Scale bar = 10um



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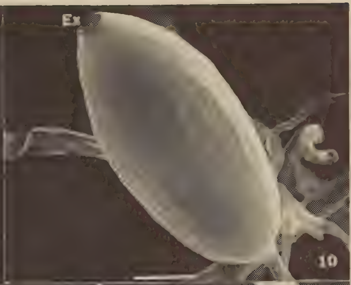

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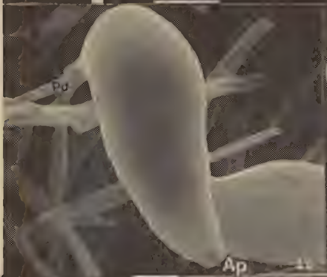

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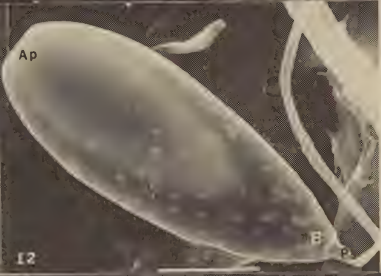

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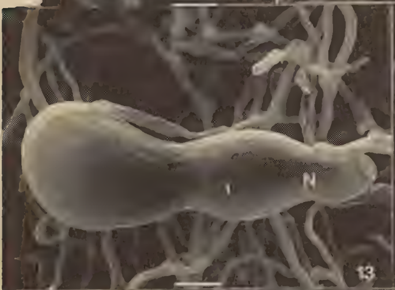

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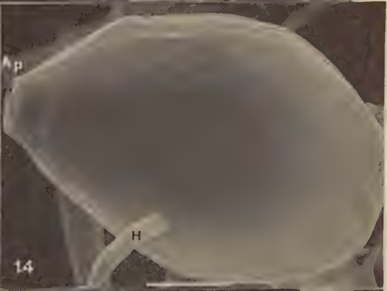

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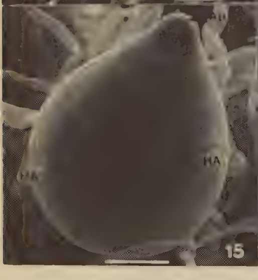

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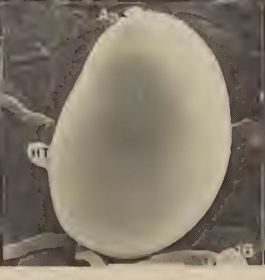

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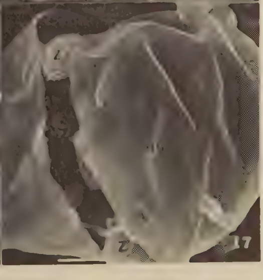

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Sex Organs

The paragynous antheridia in *P. cactorum*, *P. citricola* and *P. megasperma* are attached laterally to the surface of the oogonium (Figs. 57-59). All heterothallic and some homothallic species such as *P. boehmeriae* (Figs. 60 and 61), *P. heveae* (Figs. 62 and 63), *P. kasturae* (Figs. 64 and 65) and *P. richardiae* (Figs. 66 and 67), produce amphigynous antheridia. The amphigynous antheridium is often long and cylindrical as in *P. cinnamomi* (Figs. 68 and 69), *P. cambivora* (Fig. 70) and *P. infestans* (Figs. 71 and 72) with the spherical oogonium meeting abruptly the oogonial stalk, which is enveloped within the antheridium. In *P. heveae* (Fig. 62) and *P. kasturae* (Fig. 65), the oogonial base is long and tapering with a small spherical antheridium. The bottom of the amphigynous antheridium is depressed and penetrated by the oogonial stalk (Figs. 60, 68 and 72). A thin surface layer connects the antheridium with the oogonium and is broken later due to the expansion of the oogonium (Figs. 60 and 63), with the inner wall coiling back to form a prominent collar at the base of oogonium in many species (Figs. 60, 65 and 68). When the antheridium is separated partially from the oogonium (Fig. 61), the frayed collar and the oogonial stalk within the antheridium can be observed . The antheridium of *P. richardiae* is unique in bearing short hyphal appendages (Fig. 67). The surface of the antheridium in *Phytophthora* is smooth but the oogonial surface morphology varies with the species. *Phytophthora boehmeriae* (Fig. 60), *P. cinnamomi* (Fig. 68), *P. heveae* (Fig. 62), and *P. nicotianae* (Fig. 73) form smooth- walled oogonia. The oogonial surface is finely granular in *P. citricola* (Fig. 58), *P. cactorum* (Fig. 57), *P. cambivora* (Fig. 70), *P. kasturae* (Fig. 64), *P. capsici* (Fig. 74), *P. cryptogea* (Fig. 75) and *P. palmivora* (Fig. 76). In *P. megasperma* (Fig. 59) and *P. richardiae* (Fig. 66 and 67), the oogonial surface is coarsely granular. The oogonia of *P. colocasiae* (Fig. 77) and *P. infestans* (Fig. 71) have thick crusts of amorphous material deposited unevenly on the surface. Bullate papillae are formed randomly on the verrucose

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Fig. 18. Discharge vesicle (V) of *Phytophthora nicotianae*. Note the attachment of vesicle wall to the apex of sporangium.

Fig. 19. Papillate sporangium of *Phytophthora heveae* showing collapsed remnants of discharge vesicle attached to the edge of small exit pore (Ex).

Figs. 20,21. Sporangia of *Phytophthora cactorum* showing direct germination by one or more than one germ tubes (GT) at or near the protruding apical papilla (P).

Fig. 22. Papillate sporangium of *Phytophthora boehmeriae*. Note the protruding apex (Ap) encircled by a ring and the rough surface.

Fig. 23. Papillate sporangium of *Phytophthora botryosa*. Note the smooth surface and the protruding apex (Ap) encircled by a ring with an annular groove.

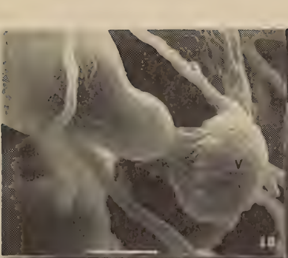
Fig. 24. Papillate sporangium of *Phytophthora capsici*. Note the protruding apex (Ap) encircled by a ring and a groove.

Fig. 25. Papillate sporangium of *Phytophthora citrophthora* showing the protruding apex (Ap) with annular ring and groove. Note the rough and slightly granular surface.

Fig. 26. Papillate sporangium of *Phytophthora heveae* showing the protruding papilla (P) and rough surface.

Figs. 27,28. Papillate sporangia of *Phytophthora meadii* showing slightly protruding apex (Ap) with annular ring and medium pecicel (Pd).

Fig. 29. Papillate sporangium of *Phytophthora nicotianae* to show the protruding apex (Ap) with annular ring. Scale bar = 1um in Figs. 19, 21, 22, and 29 while scale bar = 10um in others.



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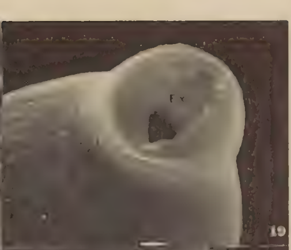

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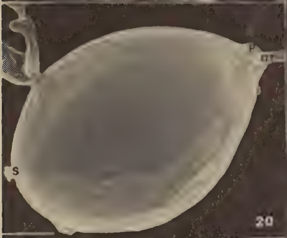

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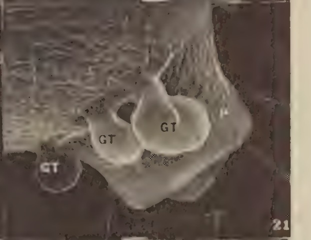

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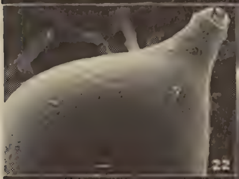

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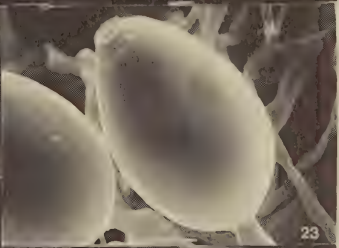

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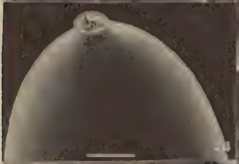

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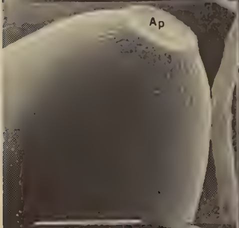

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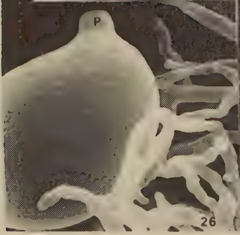

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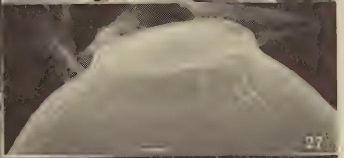

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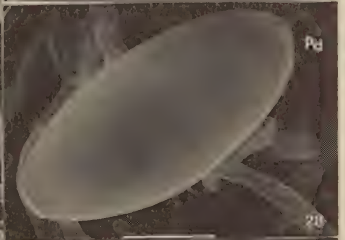

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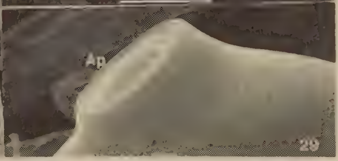

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surface of mature oogonia of *P. cambivora* (Fig. 70) and *P. kasturae* (Fig. 64), but are absent in young oogonia (Fig. 65). The sexual stage of most *Halophytophthora* species is either absent or unknown. However, two isolates of *H. epistomium* from Taiwan (Ho *et al.*, 1990) and *H. exoprolifera* (Ho *et al.*, 1992) form sex organ abundantly in single cultures. The antheridium is smooth and pressed very tightly against the oogonial stalk (Fig. 78). The surface of oogonia is smooth (Figs. 79 and 80).

DISCUSSION

In *Phytophthora*, the papilla is a characteristic feature of the sporangium and has served as a useful character for species identification (Waterhouse, 1963). In agreement with the previous information derived from LM and TEM, the present SEM studies demonstrated that the papillate sporangium has a narrow exit pore and the apex is elevated above the surrounding wall whereas the non-papillate sporangium has a wide exit pore and flattened non-protruding apex. Species classified as having semi-papillate sporangium include *P. citricola*, *P. colocasiae*, *P. hibernalis* and *P. infestans*. However, the characteristics of semi-papillate sporangia are not well defined under the SEM. In *P. hibernalis*, the sporangium has a non-protruding papilla with wide exit pore. On the other hand, *P. citricola*, *P. colocasiae* and *P. infestans* produce slightly papillate sporangia similar to those found in *P. capsici*, *P. citrophthora* and *P. botryosa*. Probably, further regrouping of *Phytophthora* species with semi-papillate sporangia might be necessary. Ho (1982) suggested that *P. colocasiae* and *P. infestans* should be classified as papillate rather than semi-papillate.

Under the light microscope, the papilla appears as a smooth, hemispherical to convex "nipple" projecting beyond the general contour of a sporangium. However, the present SEM study showed clearly a central dome-like apex surrounded by a circular ring separated by a groove. Median longitudinal sections of papillate sporangia when viewed under the TEM, also showed a depression or groove around the perimeter of

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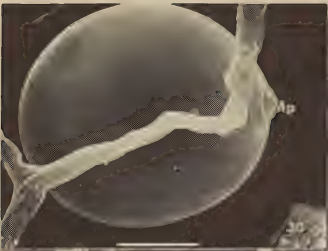
Fig. 30. Papillate sporangium of *Phytophthora palmivora* showing the rough surface, and protruding apex (Ap) with annular ring and groove.
Fig. 31. Papillate sporangium of *Phytophthora cactorum* showing outer layer (OL), inner layer (IL) and the protruding apex (Ap) with annular ring and groove.
Fig. 32. Sporangium of *Phytophthora capsici* to show two papillae (P).
Fig. 33. Papillate sporangium of *Phytophthora megakarya* to show the occluded stalk (S), basal plug (BP) and narrow exit pore (Ex). Note the rough surface.
Fig. 34. Basal view of sporangium of *Phytophthora capsici* to show the rough surface and pedicel (Pd).
Fig. 35. Papillate sporangium of *Phytophthora meadii* to show the basal septum (Se), and protruding papilla (P). Note the rather smooth surface.
Fig. 36. Papillate sporangium of *Phytophthora nicotianae* to show basal septum (Se) and sporangiophore (Sp). Note the rough surface.
Fig. 37. Semi-papillate sporangium of *Phytophthora citricola* showing the protruding apex (Ap) with annular ring and groove. Note the rough surface.
Figs. 38, 39. Semi-papillate sporangia of *Phytophthora infestans* to show the short stalk (S) and slightly protruding apex (Ap) and the annular ring. Scale bar = 1um in Fig. 38 while scale bar = 10um in others.


Ap
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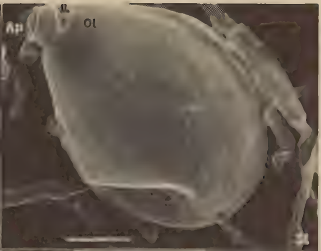
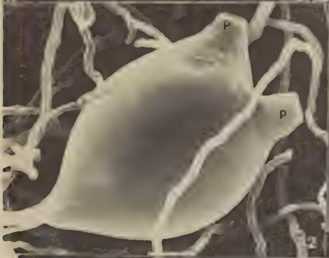
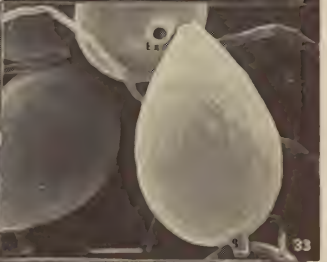

Ap
Ol


P
P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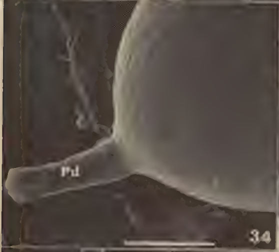
Pd
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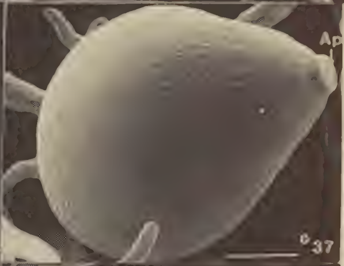
Ap
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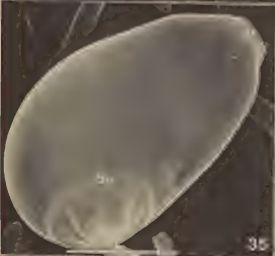
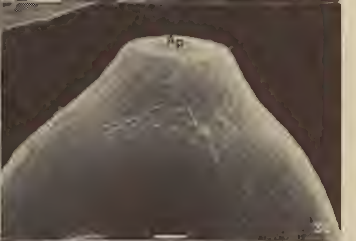
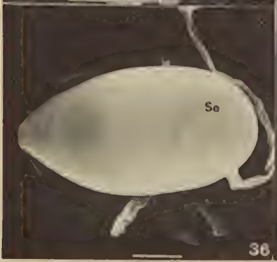

Se
35


Ap


Se
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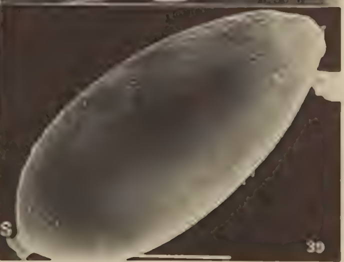
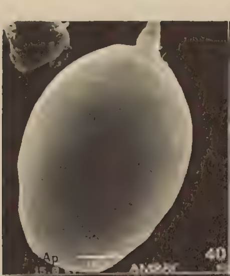

S
39

the papilla near the apical end, as demonstrated in *P. palmivora* (Christen and Hohl, 1972), *P. infestans* (King *et al.*, 1968) and *P. heveae* (Hemmes, 1983). On the other hand, it can be argued that the dome-groove-ring organization of the apical papilla may be an artifact due to specimen preparation or high vacuum used in the SEM. Turnau (1988) found that as a result of CPD, the apex of an ascus became depressed in an otherwise smooth, semi- spherical ascus top. It is possible that the junction of the plug material and the secondary wall forms the circular groove between the dome-like apical thickening and the surrounding sporangial wall which appears as the annular ring. In *Phytophthora*, the sporangial wall as seen with the TEM consists of two layers, an outer thin continuous layer over the apex and a thick inner layer tapering off near the apical plug (Hohl and Hammamoto, 1967; Willams and Webster, 1970; Hemmes, 1983). It is possible that the absence of glucans and cellulose in the plug material (King *et al.*, 1968)and the lack of support from the inner wall near the crown might cause the sporangial apex to become depressed during specimen preparation or under high vaccum when observed with SEM. A combination of SEM and TEM techniques using frozen-hydrated and fractured material is thus called for to attempt to provide an answer to the true nature of the sporangial apex. During zoospore release, the apical plug balloons into a discharge vesicle (Gisi *et al.*, 1979). In the present study, the vesicle wall is shown to be attached to the sporangial wall thus confirming previous observation under TEM.

In most *Phytophthora* species, the surface of sporangial wall exhibits a coarse texture. However, the "distinct reticulate ridge-type patterns" on the surface of the sporangial wall as described by Khan *et al.* (1988) in their SEM study of *P. nicotianae* var. *nicotianae*, cannot be confirmed. Instead, the sporangial surface of this species appears rough to granular in present study. In most cases, the difference in surface morphology of sporangia is not distinct and constant enough to be specific for the species. Perhaps, other techniques like surface replica and freeze-fracturing may be of greater value in revealing the fine details of surface architecture.

The oogonial wall of most species is smooth under the LM, but the present SEM study demonstrates that the oogonial surface may be smooth, finely granular or coarsely granular, thus supporting the findings by Honour (1973), Ho *et al.*, (1977) and Ho (1979a). It is possible to segregate *Phytophthora* species studied into five groups based on the surface morphology of the oogonia revealed by the SEM: (1) bullate in *P. cambivora* and *P. kasturae,* (2) thick crust in *P. colocasiae* and *P.*

Figs. 40-42. Non-papillate sporangia of *Phytophthora cinnamomi* showing the caved-in apex (Ap) with the flattened tip and the circular ring. Note the smooth surface.
Figs. 43, 44. Non-papillate sporangia of *Phytophthora cryptogea* to show the caved-in apex with the convex tip.
Fig. 45. Non-papillate sporangium of *Phytophthora megasperma* showing wide exit pore (Ex).
Fig. 46. Non-papillate sporangium of *Phytophthora richardiae* showing wide, flat apex (Ap) and sympodial branching (Br) of sporangiophore.
Figs. 47,48. Spherical sporangia of *Halophytophthora epistomium* showing the long and straight dehiscence tube (DT) and the smooth plug (Pl).
Fig. 49. Pyriform sporangium of *Halophytophthora bahamensis* with short dehiscence tube (DT). Scale bar = 1um in Figs. 42, 43 while scale bar = 10um in others.



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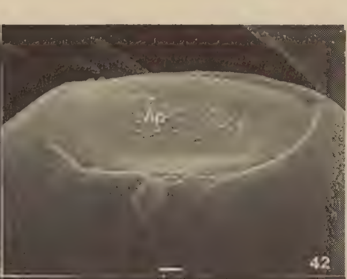

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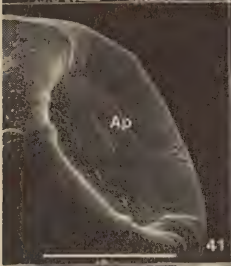

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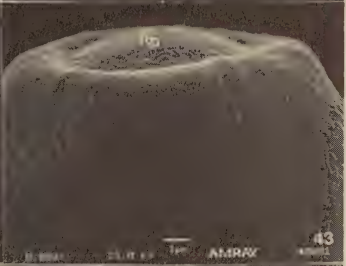

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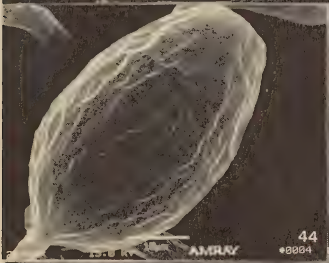

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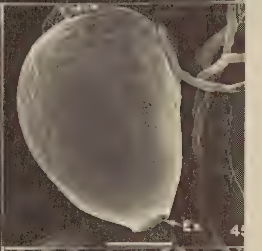

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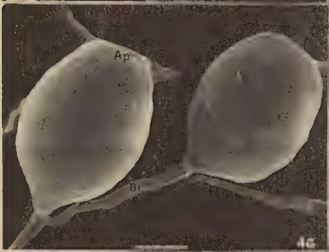

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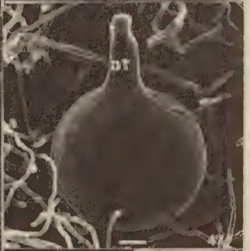

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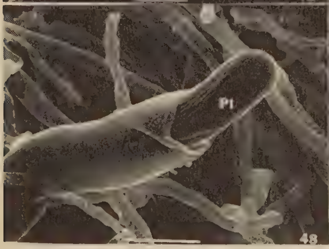

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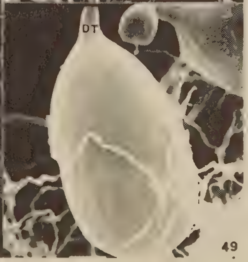

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infestans, (3) coarsely granular in *P. megasperma* and *P. richardiae*, (4) finely granular in *P. cactorum*, *P. citricola*, *P. cryptogea*, *P. megakarya* and *P. palmivora*, (5) smooth in *P. boehmeriae*, *P. cinnamomi*, *P. heveae* and *P. nicotianae*. However, further studies are needed to determine the possible effect of age and cultural condition on the surface morphology of oogonia (Honour, 1973). A very thick amorphous layer was also observed on the oogonia of *P. colocasiae* and *P. infestans*. After the amorphous layer was removed, the oogonial surface appeared slightly wrinkled like the sporangial surface. It is possible that the appearance of the oogonial surface in some *Phytophthora* species might be due to the distribution pattern of the amorphous layer, as suggested by Ho (1979a).

Antheridial configuration is another important character used for the identification of *Phytophthora* species . Our SEM micrographs confirmed the collar structure on the amphigynous antheridium observed with the TEM (Vujicic, 1971; Hemmes and Barntuicki-Garcia, 1975; Ho, 1979b) and the SEM (Honour, 1973; Ho *et al.*, 1977). The "vertical junction" in the antheridial surface as described by Stephenson and Erwin (1972) could not be found. Our observations support the classical concept of amphigyny that the oogonial initial pierces and grows through the antheridial initial (Pethybridge, 1913; Vujicic, 1971; Hemmes and Bartnicki- Garcia, 1975) but not the theory proposed by Stephenson and Erwin (1972) that the oogonial initial is encircled by the antheridial initial. Ho (1979b) suggested that the proximal end of the antheridium is not immediately pierced, but pushed in by oogonial initial, so that the appearance of the collar depends on the time of the rupture of the fused antheridial wall.

Although saprophytic primarily on decaying leaves in sea water instead of being parasitic on plants like most terrestrial *Phytophthora* species, isolates of *Halophytophthora* have been placed in the genus *Phytophthora* because of the fashioning of zoospores within the sporangium (Stamps *et al.,* 1990). The SEM micrographs show that in most *Halophytophthora* species, the sporangial apex extends into a distinct, plugged or unplugged dehiscence tube which is not found in any terrstrial plant-pathogenic *Phytophthora* species. The sporangium of *H. operculata* is unique in opening apically by a hinged lid and the spiny sporangial wall of *H. spinosa* differs from the smooth to rough sporangial wall found in all other species of *Phytophthora*. The preaent SEM study also reveals the nature of

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Figs. 50,51. Sporangia of *Halophytophthora exoprolifera* showing the dehiscence tube (DT) in Fig. 50.

Fig. 52. Sporangium of *Halophytophthora operculata* after zoospore release showing hinged operculum (OP) and exit pore (Ex).

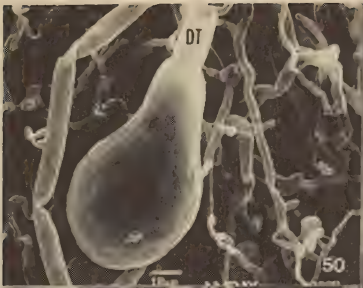
Fig. 53. Sporangium of *Halophytophthora spinosa* var. *lobata* with spines all over the surface.

Fig. 54. Sporangium of *Halophytophthora spinosa* var. *spinosa* showing spines nearapex.

Fig. 55. Sporangium of *Halophytophthora batemanensis* showing the non-papillate apex and rough wall.

Fig. 56. Sporangium of *Phytophthora vesicula* showing the truncated apex.

Fig. 57. Oogonium (O) and paragynous antheridium (PA) of *Phytophthora cactorum.* Note the finely granular oogonial surface and oogonial stalk (OS). Scale bar = 10um.



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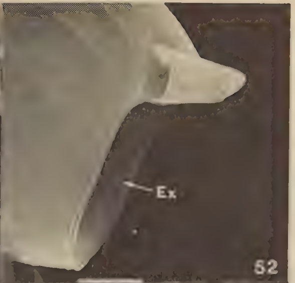

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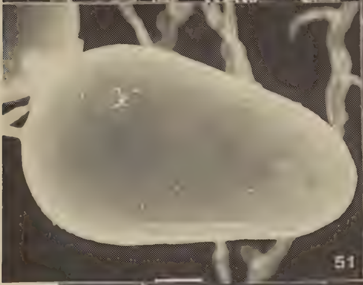

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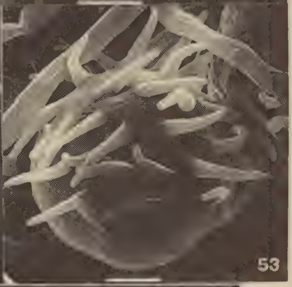

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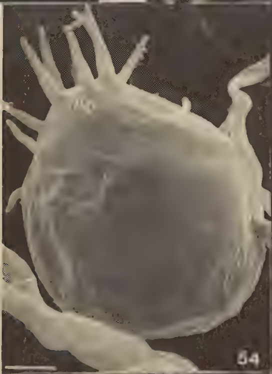

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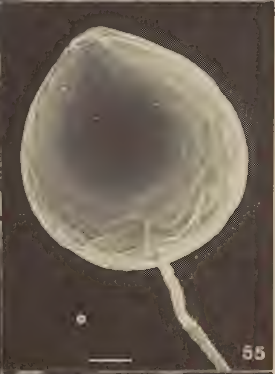

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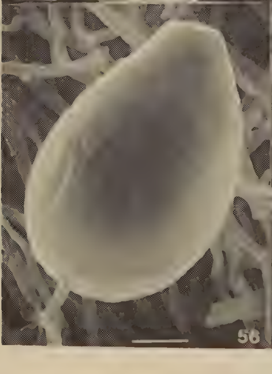

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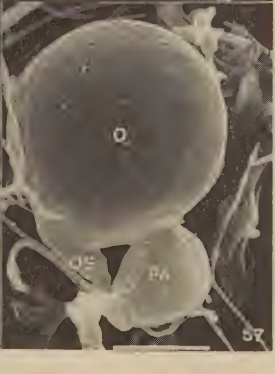

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antheridial configuration in the marine species. The antheridium is pressed very tightly to and interwinded with the oogonial stalk that it "appears" as amphigynous, but is distinctly paragynous when observed with the SEM. Ho and Jong (1990) proposed that the marine species are distinct enough to be considered belonging to a new genus: *Halophytophthora*. Waterhouse *et al.*, (1983) also suggested to exclude the marine species from *Phytophthora* based on the apical structure and the mode of zoospore emission. There seems to be sufficient evidence to separate the marine species of *Phytophthora* into a new genus based on the SEM observation.

In summary, it can be concluded that SEM has proved to be a useful tool in the study of the morphology of *Phytophthora* and *Halophytophthora* species. In addition to confirming previous observations, the present SEM study has provided additional information. It is unlikely that the morphological characteristics revealed by the SEM alone permit immediate identification of *Phytophthora* species but it is hopeful that they will contribute to the taxonomy of *Phytophthora* in general.

ACKNOWLEDGMENT

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Fig. 58. Oogonium (O) and paragynous antheridium (PA) of *Phytophthora citricola*. Note the oogonial stalk (OS), finely granular oogonial surface and smooth antheridium surface.

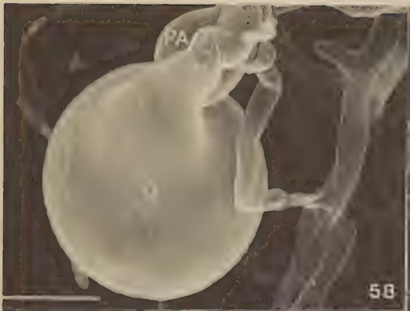
Fig. 59. Oogonium (O) and paragynous antheridium (PA) of *Phytophthora megasperma*. Note the oogonial stalk (OS) and the coarsely granular oogonial surface.

Figs. 60,61. Oogonia (O) and amphigynous antheridia (AA) of *Phytophthora boehmeriae*. Note the oogonial stalk (OS) entering the base of the amphigynous antheridium and the collar (C) at the other end of the antheridium.

Figs. 62,63. Oogonia (O) and amphigynous antheridia (AA) of *Phytophthora heveae* showing the long and tapering oogonial base (OB), the small spherical antheridium and the thin wall layer (L) connecting the oogonium and antheridium. Note the smooth oogonial surface.

Figs. 64,65. Oogonia (O) and amphigynous antheridia (AA) of *Phytophthora kasturae* showing the long and tapering oogonial base (OB) and the small spherical antheridium with antheridial collar (C). Note the bullate papillae (Pa) on the granular-walled oogonial surface.

Scale bar = 1um in Fig. 63 while scale bar = 10um in others.



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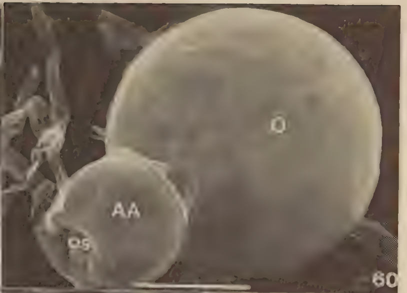

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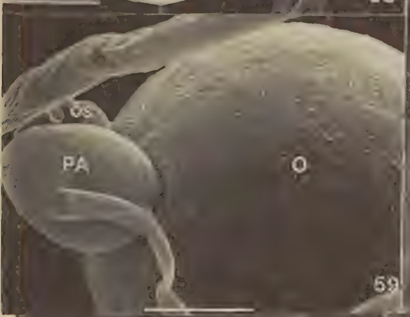

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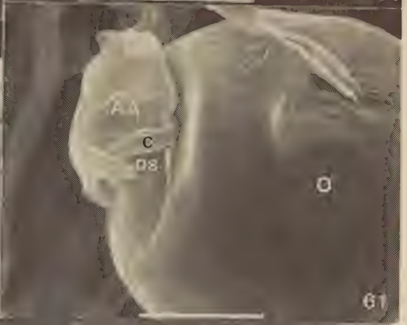

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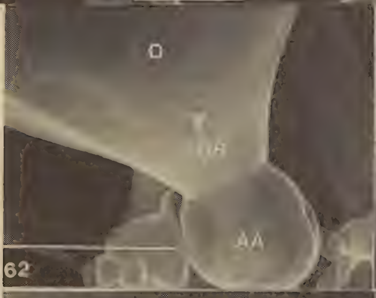

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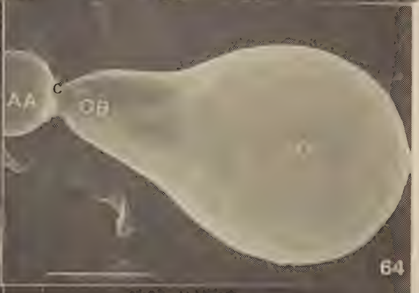

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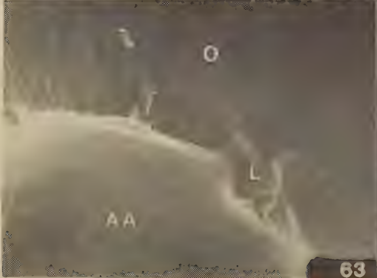

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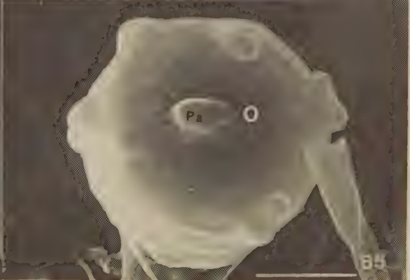

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Figs. 66,67. Oogonia (O) and amphigynous antheridia (AA) of *Phytophthora richardiae*. Note the hyphal appendages (HA) and collar (C) of antheridium, the oogonial stalk entering the antheridial base and the coarsely granular oogonial surface.

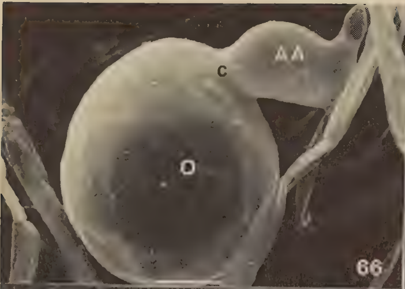
Figs. 68,69. Oogonia (O) and long amphigynous antheridia (AA) of *Phytophthora cinnamomi*. Note the antheridium pushed in by oogonial stalk (OS), the antheridial collar (C) and the smooth oogonial surface.

Fig. 70. Oogonium (O) and amphigynous antheridium (AA) of *Phytophthora cambivora*. Note the bullate papillae (Pa) on the oogonial surface.

Figs. 71,72. Oogonia (O) and amphigynous antheridia (AA) of *Phytophthora infestans*. Note the thick crust (Cr) on the oogonial surface, the rugulose surface after partially removing the crust, the antheridium pushed in by oogonial stalk (OS) and the antheridial collar (C).

Fig.73. Oogonium (O) and amphigynous antheridium (AA) of *Phytophthora nicotianae*. Note the antheridium pushed in by oogonial stalk (OS) and the antheridial collar (C).

Fig. 74. Oogonium (O) and amphigynous antheridium (AA) of *Phytophthora capsici*. Note the granular surface of oogonium. Scale bar = 1um in Fig.74 while scale bar = 10um in others.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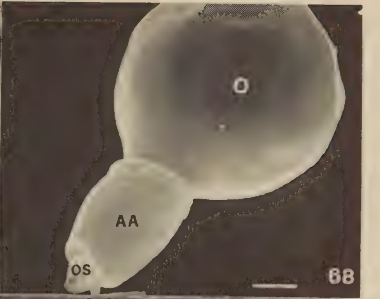
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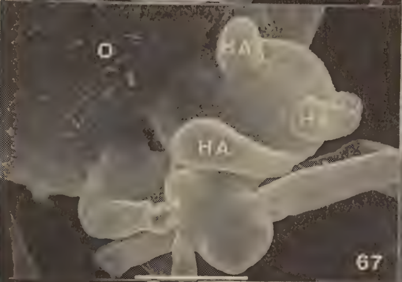
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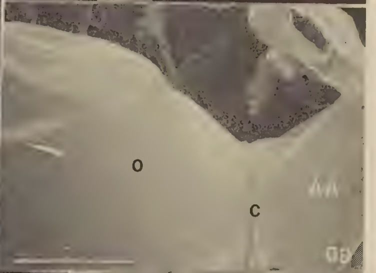
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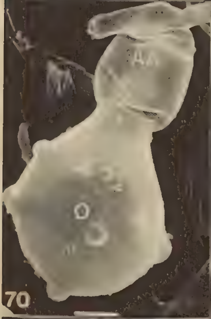
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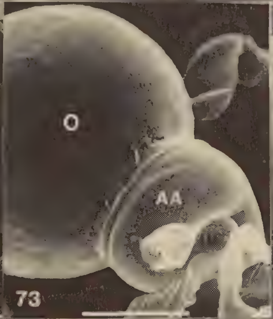
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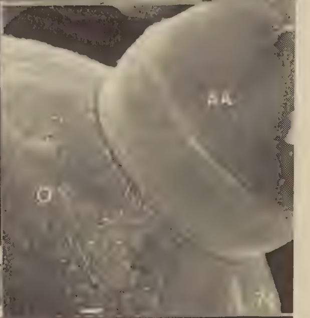
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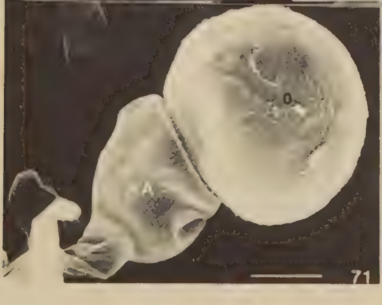
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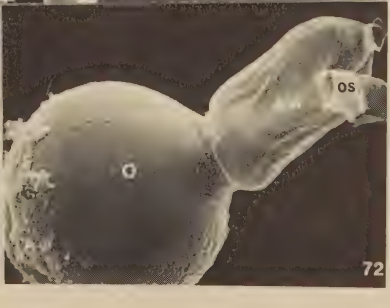
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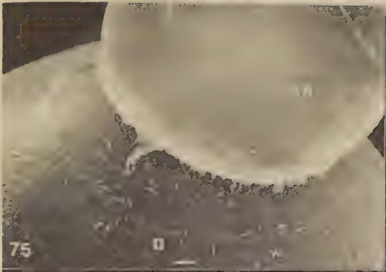
Fig. 75. Oogonium (O) and amphigynous antheridium (AA) of *Phytophthora cryptogea* showing the rough oogonial surface, smooth antheridial surface and the antheridial collar (C).

Fig. 76. Oogonium (O) and amphigynous antheridium (AA) of *Phytophthora palmivora* showing the antheridial collar (C) and the cross wall (CW) of bicellular antheridium.

Fig. 77. Oogonium (O) and amphigynous antheridium (AA) of *Phytophthora colocasiae*. Note the thick crust (Cr) on the oogonial surface.

Fig. 78. Oogonium (O) and antheridium of *Phytophthora epistomium*. Note the paragynous antheridium (PA) pressed tightly to the oogonial stalk (OS) and the smooth oogonial surface.

Figs. 79,80. Oogonia and antheridia of *Halophytophthora exoprolifera*. Note the paragynous antheridium (PA) pressed tightly to the oogonial stalk (OS) and the smooth oogonial surface. Scale bar = 10um.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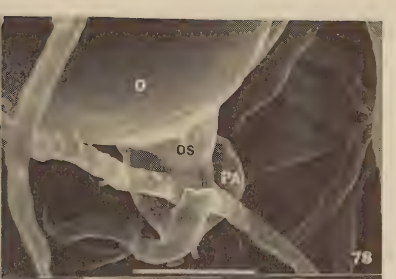
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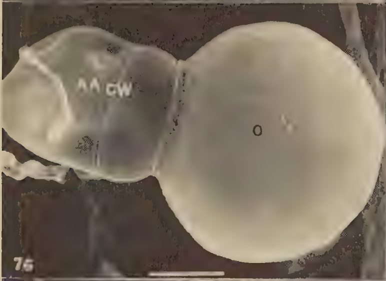
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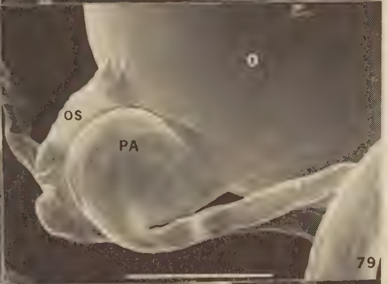
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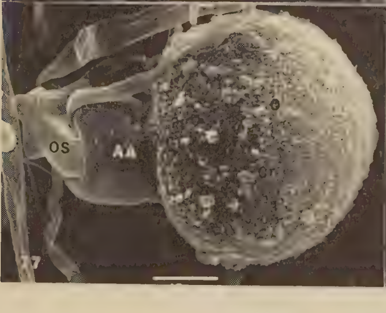
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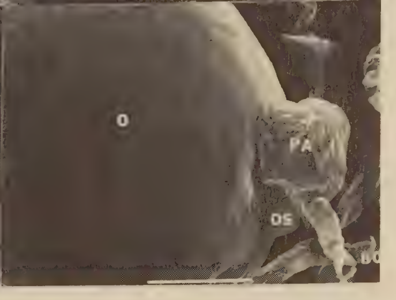
O
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Table 1
Isolates of *Phytophthora* and *Halophytophthora* used in the study

Phytophthora sp.	Isolates	Mating Type	Host/Substrate	Origin
P. bohmeriae	66215*	Homothallic	Unknown	Unknown
P. botryosa	26479	A1	*Theobromae cacao*	Malaysia
	26481	A1	*Hevea brasiliensis*	Malaysia
	52221	A2	Rubber Tree	Malaysia
P. cactorum	66097	Homothallic	Unknown	Unknown
P. cambivora	36228	A2	*Malus sylvestris*	Australia
	38811	A1	Apple	Japan
P. capsici	46707	A2	Cacao	El Salvador
	64531	A1	Pepper	Italy
P.cinnamomi	32992	A2	Avocado	California
	32993	A1	Camellia	California
	58008	A2	Black walnut	California
P. citrocola	32994	Homothallic	Avocado	California
	52230	Homothallic	Avocado	Mexico
P. citrophthora	52143	A1	Citrus	California
P. colocasiae	76180	A1	Taro	Taiwan
	OI1	A1	Taro	Taiwan
P. cryptogea	46721	A1	*Aster*	California
P. heveae	16700	Homothallic	*Hevea* sp.	Malaysia
	58815	Homothallic	*Hevea brasiliensis*	Malaysia
	64863	Homothallic	*Eucalyptus*	Australia
P. hibernalis	64708	Homothallic	*Aquilegia vulgaris*	New Zealand
P. infestans	16980	A1	Tomato	Indiana
	32835	A2	Potato	Mexico
	44355	A1	*Solanum tuberosum*	W. Virginia
P. katsurae	36818	Homothallic	Soil	Taiwan
	58426	Homothallic	Coconut	Hawaii
P. meadii	52236	A1	Unknown	Unknown
	58103	A2	*Hevea brasiliensis*	India
P.megakarya	26201	A1	*Theobroma cacao*	Nigeria
P. megasperma	48606	Homothallic	Douglas fir	Washington
	58012	Homothallic	Black walnut	California
P. nicotianae	38606	A2	Soil (Citrus)	California
	38607	A1	Soil (Citrus)	California
P. palmivora	26200	A2	Cacao	Costa Rica

Table 1 (continued)

Phytophthora sp.	Isolate	Mating Type	Host/Substrate	Origin
P. palmivora	52152	A1	Cacao	Dominican Republic
	52146	A2	Orchid	Hawaii
P. richardiae	46734	Homothallic	Unknown	Unknown
Halophytophthora sp.	Isolates	Mating Type	Host/Substrate	Origin
H. bahamensis	64761	Neuter	Mangrove leaf	Bahama Islands
H. batemanensis	56965	Neuter	*Avicennia* leaf	Australia
H. epistomium	76185	Homothallic	*Kendelia candel* leaf	Taiwan
	76186	Homothallic	*K. candel* leaf	Taiwan
H. polymorphica	56966	Neuter	*Eucalyptus* leaf	Australia
H. exoprolifera	SAP44	Homothallic	Mangrove leaf	Bahama Islands
H. spinosa var. *lobata*	28291	Neuter	Decaying leaf	Florida
H. spinosa var. *spinosa*	22894	Neuter	Decaying leaf	Florida
H. vesicula	48641	Neuter	Mangrove leaf	Florida

* American Type Culture Collection accession number

MYCOTAXON

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ON THE TYPIFICATION OF *Phoma sacchari* (Cooke) Sacc.

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ABSTRACT

The holotype and three isotypes of *Sphaeropsis sacchari* Cooke (later *Phoma sacchari* (Cooke) Sacc.) were studied by bright field and interference contrast microscopy. The examination revealed the presence of spores and other elements belonging to ten fungi different from *Phoma*. The more common structures observed, and the only ones identifiable, were assigned to *Botryosphaeria quercuum* (Schwein.) Sacc. (Ascomycotina) and to *Cytospora sacchari* Butl. (deuteromycetes). Evidence that the other visualized structures do not relate to the original description of the investigated species is presented. It is concluded that *Phoma sacchari* (Cooke) Sacc. is a dubious name and since it cannot be applied with any degree of certainty, should not be used.

SOBRE LA TIPIFICACION DE *Phoma sacchari* (Cooke) Sacc.

RESUMEN

El holotipo y tres isotipos de la especie *Sphaeropsis sacchari* Cooke (posteriormente *Phoma sacchari* (Cooke) Sacc.) fueron examinados mediante microscopía óptica de campo luminoso y de contraste diferencial de interferencia. El examen reveló la presencia de esporas y de otros elementos fúngicos separables en diez entidades no referibles a *Phoma*. Las estructuras más frecuentes y las únicas identificables fueron asignadas a las especies *Botryosphaeria quercuum* (Schwein.)Sacc. (Ascomycotina) y a *Cytospora sacchari* Butl. (deuteromycetes). Se presenta evidencia de que las otras estructuras visualizadas no guardan relación con la descripción original de la especie investigada. Se concluye que *Phoma sacchari* (Cooke) Sacc. es un nombre dudoso y puesto que no puede ser aplicado con certeza no debe ser utilizado.

INTRODUCTION

Phoma sacchari (Cooke) Sacc. was first described as *Sphaeropsis sacchari* Cooke on the basis of sugarcane material collected by H.W. Ravenel in

Darien, Georgia, U.S.A. in 1881. Cooke's description ran as follows "*Sparsum vel in plagias irregulares consociatum. Peritheciis atris, subglobosis, erumpentibus. Sporis lanceolatis, hyalinis* (0,032-0,042 x 0,012 mm)" (Cooke, 1883-84).

Obviously, this description does not present sufficiently distinctive criteria for generic designation, let alone for a specific one, in modern terms. When Saccardo (1884) transfered *S. sacchari* to the genus *Phoma*, he transcribed Cooke's original description literally, which suggests that he did not examine the type material of the species.

Berlese and Voglino (1886) raised *Phoma* subgenus *Macrophoma* to generic rank as *Macrophoma* (Sacc.) Berl. & Vogl. The species *Phoma sacchari* (Cooke) Sacc. was placed in the new genus as *M. sacchari* (Cooke) Berl. & Vogl. (Berlese & Voglino, 1886; Saccardo, 1892, 1901).

Sutton (1980) reduced *Macrophoma* to synonymy with *Sphaeropsis* Sacc. This situation left *Phoma sacchari* (Cooke) Sacc. as the most acceptable name for the species originally described as *S. sacchari.*

During the taxonomic study of *Phoma* and *Phyllosticta* species described on *Saccharum* sp. (Pons, 1990), *P. sacchari* (Cooke) Sacc. could not be characterized because of the heterogeneous condition of the 'type' material examined. This led to the tracing and study of the extant duplicates (isotypes) in order to elucidate the status of the species.

MATERIALS AND METHODS

Four 'type' specimens were borrowed for examination. One of these, the collection H.W. Ravenel 3173, sent on loan by the Royal Botanic Gardens, Kew (K), is regarded as the holotype of *P. sacchari* (Cooke) Sacc. because Ravenel's main collections are deposited in K or in the Farlow Herbarium (FH). The latter does not keep any duplicate of Ravenel 3173.

The other three specimens (two marked as 'type' and one as 'isotype') were provided by the National Fungus Collections (BPI). No other type material of *P. sacchari* (Cooke) Sacc. could be traced in the British Museum Cryptogamic Herbarium, London (BM) or in the Smithsonian Institution, U.S.A. (US).

All specimens consisted of pieces of old culms of *Saccharum officinarum* L., exhibiting protuberances, crackings and erumpent fungal structures (Fig. 1). Whole and squash preparations and microtome sections 10-15 µm thick were examined by bright field and interference contrast microscopy.

RESULTS AND DISCUSSION

All the specimens proved to be heterogeneous. The holotype showed spores and stromatic structures referable to eight different fungi.

The characteristics exhibited by some consistently observed structures were sufficient to allow the identification of *Botryosphaeria quercuum*

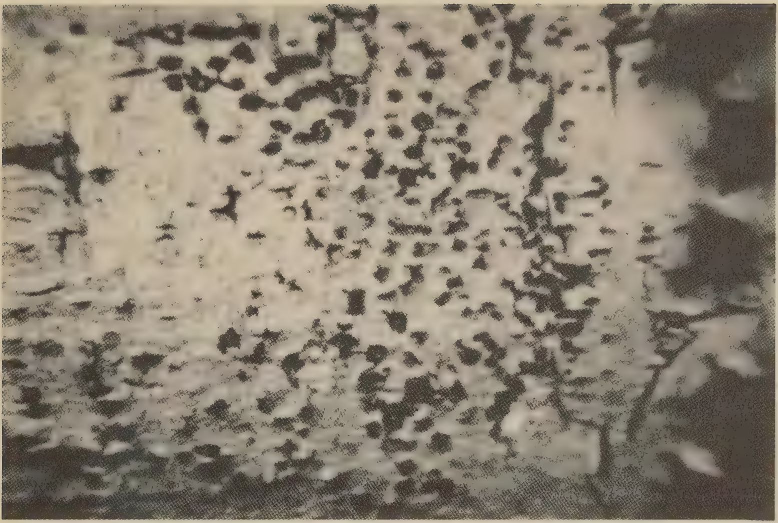

Fig. 1. Protuberances, crackings and erumpent fungal structures on the surface of culms of *Saccharum officinarum* (Ravenel 3173, holotype of *P. sacchari*).

(Schwein.) Sacc. (Ascomycotina) (Fig. 2) and *Cytospora sacchari* Butl. (deuteromycetes) (Figs. 3, 4).

Isolated spores and stromatic bodies without fertile elements were also seen on the holotype. The spores displayed a variety of shapes and were either strongly pigmented with smooth or verruculose walls and 0-2 septate, or hyaline, smooth and 3- septate (Fig. 5).

Another portion of the holotype provided by K in a second loan, also produced *B. quercuum* and *C. sacchari* structures. This material additionally showed some empty stromatic bodies.

In one of the three isotypes from BPI, there were a few fragments of stromata belonging to *C. sacchari* and two distinct unidentifiable pycnidial-like structures. The other two isotype collections only had empty stromata.

The fungal elements observed in all the type materials examined can be separated into ten entities or groups.

Apart from the structures belonging to *B. quercuum* and to *C. sacchari*, the remaining elements are insufficient to allow identification even at a generic level.

The features exhibited by the spores observed separately, indicate no relationship with the genus *Phoma* Sacc. which is characterized by having hyaline, aseptate or occasionally 1-septate conidia (Sutton, 1980).

Article 7.4 of the International Code of Botanical Nomenclature (Greuter, 1988) states that when the material designated as type is found to belong to more than one taxon, a lectotype or a neotype, if permissible, must

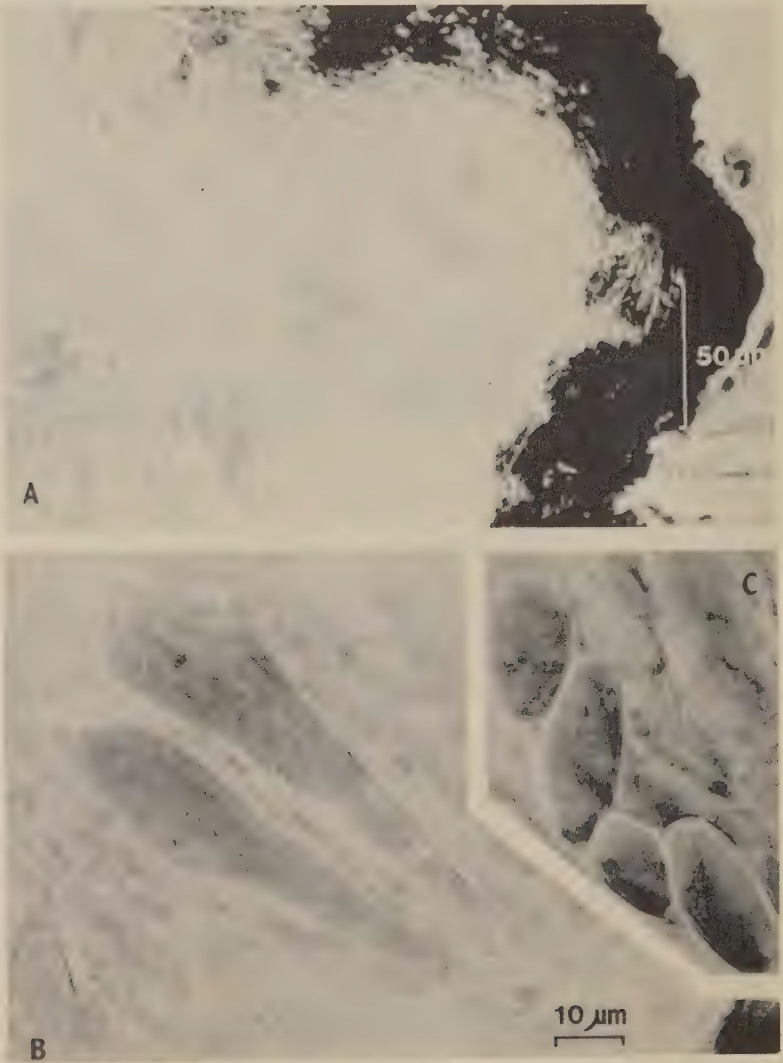

Fig. 2. *Botryosphaeria quercuum* (Ravenel 3173, holotype of *P. sacchari*) A, Ascoma section showing locus with asci, acospores and external thick wall, B, Bitunicate asci, C, Ascospores.

be designated. Article 9.2 stipulates that if a type consisting of more than one individual (in this case two or more pieces of culms) contains parts belonging to more than one taxon (Art. 7.4), the name must remain attached to that part (lectotype) which corresponds most nearly with the original description.

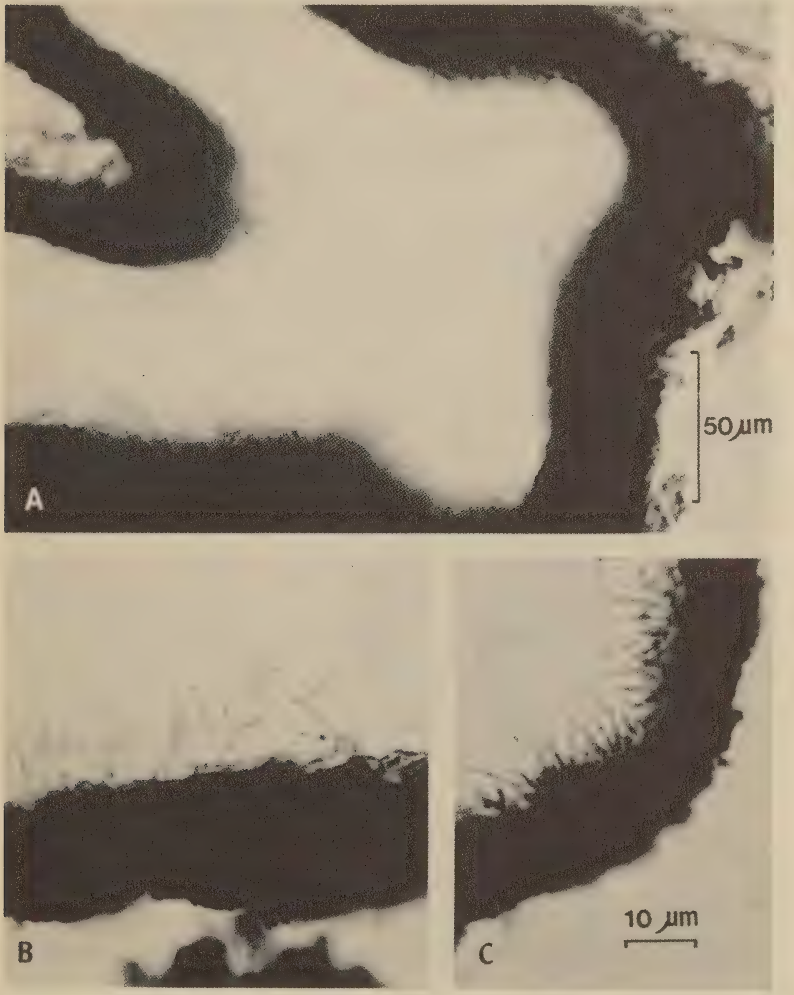

Fig. 3. *C. sacchari* (Ravenel 3173, holotype of *P. sacchari*) A, conidiomal locus B, Conidiophores bearing conidiogenous cell and conidia. C, discrete conidiogenous cells with conidia.

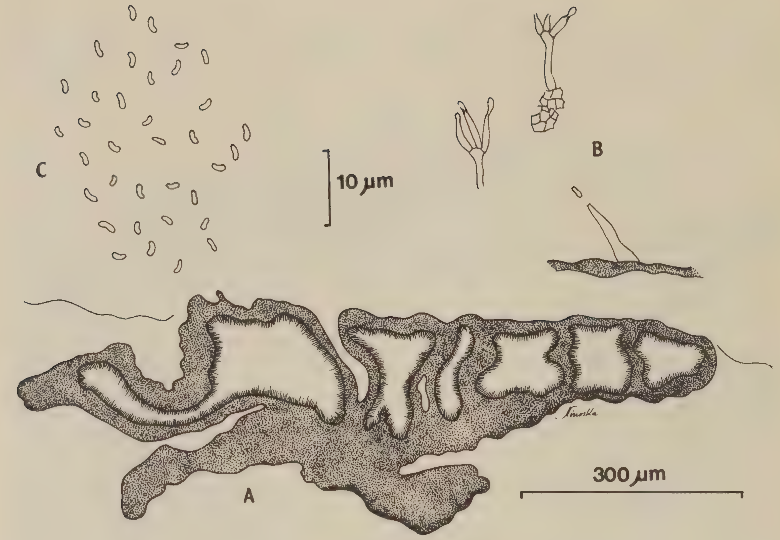

Fig. 4. *Cytospora sacchari* (Ravenel 3173, holotype of *S. sacchari*) A, Longitudinal section of multilocular convoluted conidioma. B, Conidiogenous cells in different stages of conidiogenesis, C, Conidia.

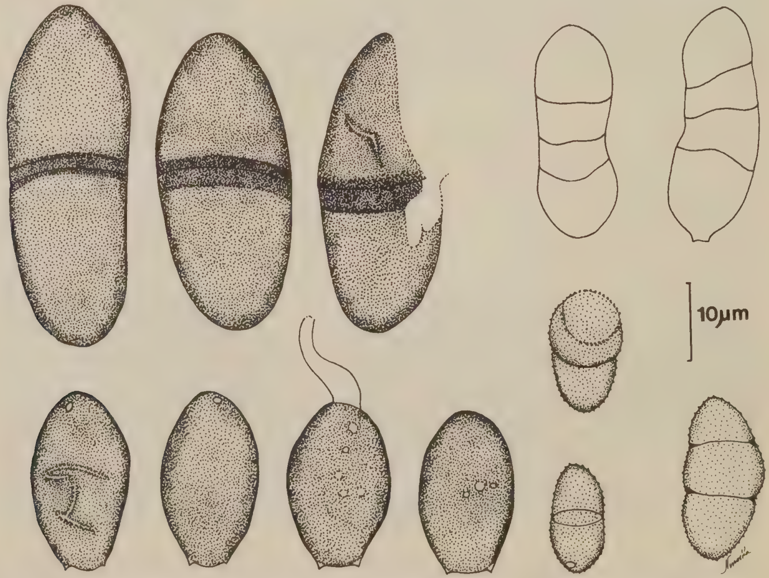

Fig. 5. Various spores observed in the collection Ravenel 3173 (holotype of *P. sacchari*).

In the case of *P. sacchari* (Cooke) Sacc. the lectotypification is not possible because once the more frequently observed structures in the type have been separated into *B. quercuum* and *C. sacchari*, the remaining elements do not correspond with the original account of *P. sacchari*.

The option of designating a neotype is rejected because when the species was introduced, the fungus was not characterized sufficiently clearly and there is no foundation on which to select a specimen taxonomically similar.

The conclusion is that *Phoma sacchari* (Cooke) Sacc. is a name of dubious application. Since it cannot be applied with any degree of certainty it should not be used.

Fortunately, this name is not currently mentioned in phytopathological literature (Sivanesan & Waller, 1986; Stand. Com. Sugarcane Dis., 1983). Apparently, it is only known by the original description. A later homonym, *Phoma sacchari* Gutner was recently substituted by the new name *Phoma gutneri* Pons (Pons, 1990).

AKNOWLEDGEMENTS

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GASTEROMYCETES CHECKLIST OF THE NORTHEASTERN IBERIAN PENINSULA AND BALEARIC ISLANDS

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ABSTRACT

This checklist of Balearic Islands and the NE Iberian Peninsula covers all the previously recorded taxa. It contains a complete list of species and lower taxa set out in alphabetical order within each genus. A total of 130 species, 2 varieties and 1 form have been listed for the area surveyed.

KEY WORDS: *Gasteromycetes*, Iberian Peninsula, Balearic Islands

THE SURVEYED AREA

The area covered by this checklist is located in the northeastern part of the Iberian Peninsula including the Balearic Islands. It is situated between 1º 15' long. W Gr and 4º 20'long. E Gr, and between 37º 40' and 43º lat. N. Roughly, its surface covers of 70.000 sq. Km. Both from the physiographic and the biogeographic points of view it is very diverse. It stretches over three phytogeographic regions: boreo-alpine, euro-siberian and mediterranean.

HISTORICAL PRECEDENTS

From an historic point of view, this checklist is the compilation of all previous *Gasteromycetes* records published in the local literature.

The mycological research in the surveyed area can be divided into four different periods:

1.- At the beginning of the twentieth century, the contributions are scarce. KNOCHE (1921) in his *Flora Balearica* records 15 species of *Gasteromycetes*. In their work *Introducció a l'estudi dels macromicets de Catalunya*, Codina and Font i Quer (1930) compile 56 papers and 2 original manuscripts in the first comprehensive census of the macromycetes: 627 species, 39 of which belong to the *Gasteromycetes*.

2.– During the thirties Font i Quer organized a number of forays (*Pla Quinquennal Micológic de Catalunya*, 1931–1935). The local specialists were supplemented with the invitation of mycologists so skilled as A.A. Pearson, R. Maire, R. Heim, R. Singer *et alia*. In 1935, the 1st General Sesion of the *Société Mycologique de France* was held in Barcelona. As a result of all this work, the catalogue of fungi grew to 745 taxa, 19 of which were *Gasteromycetes*.

3.– During the postwar period the number of published works were very scarce. Only 8 papers in 30 years with 2 new records of *Gasteromycetes*.

4.– Beginning in the 1970s appeared a new interest in mycology. The *Societat Catalana de Micologia* was founded in 1972. Since this year a lot of mushroom shows have been organized and the number of published works has grown spectacularly. The census of *Gasteromycetes* is enriched by 75 taxa. Presently, the catalogue of *Gasteromycetes* of the Northeastern Iberian Peninsula and Balearic Islands reaches the figure of 135 taxa.

CLASSIFICATION

We have ordered the different taxa in three categories: epigeous, hypogeous and agaricoids, following JULICH (1984). Every taxonomic category (order, family and genus) has been alphabetically arranged.

EPIGEOUS GASTEROMYCETES

Lycoperdales

Geastraceae

Geastrum Pers.
Myriostoma Desv.

Lycoperdaceae

Arachnion Schw.
Bovista Pers.: Pers.
Bovistella Morg.
Calvatia Fr.
Disciseda Czernajev
Gastropila Hormrich & Wrigth
Langermannia Rostk.
Lycoperdon Tourn. ex Pers.: Pers.
Vascellum Šmarda

Nidulariales

Nidulariaceae

Crucibulum Tul.
Cyathus Haller: Pers.
Mycocalia J.T. Palmer

Phallales

Clathraceae

Clathrus Pers.
Colus Cav. et Séch.
Ileodictyon Tul.

Phallaceae

Lysurus Fr.
Mutinus Fr.
Phallogaster Morg.
Phallus Hadr. Junius ex Pers.

Sclerodermatales

Astraeaceae

Astraeus Morg.

Pisolithaceae

Pisolithus Alb. et Schw.

Sclerodermataceae

Scleroderma Pers.

Sphaerobolaceae

Sphaerobolus Tode: Pers.

Tulostomatales

Tulostomataceae

Battarrea Pers.
Tulostoma Pers.

HYPOGEOUS GASTEROMYCETES

Gastrosporiales

Gastrosporiaceae

Gastrosporium Mattir.

Gautieriales

Gautieriaceae

Gautieria Vitt.

Hymenogastrales

Hydnangiaceae

Hydnangium Wallr.
Hymenogaster Vitt.

Octavianinaceae

Octavianina O. Kuntze
Sclerogaster Hesse
Wakefieldia Corner et Hawker

Rhizopogonaceae

Rhizopogon Fr.

Stephasnosporaceae

Stephanospora Pat.

Hysterangiales

Hysterangiaceae

Hysterangium Vitt.

Leucogastrales

Leucogastraceae

Leucogaster Hesse

Melanogastrales

Melanogastraceae

Alpova Dodge
Melanogaster Corda

AGARICOID GASTEROMYCETES

Agaricales s.l.

Endoptychum Czernajev
Galeropsis Singer
Gyrophragmium Mont.
Montagnea Fr.

Torrendia Bres.

Russulales s.l.

Martellia Matt.

INTRODUCTION TO THE CHECKLIST

The taxa included in this checklist, both genus and species, have been arranged alphabetically. Within each species, the bibliographical source of records are ordered chronologicaly. All synonymous used for the records in

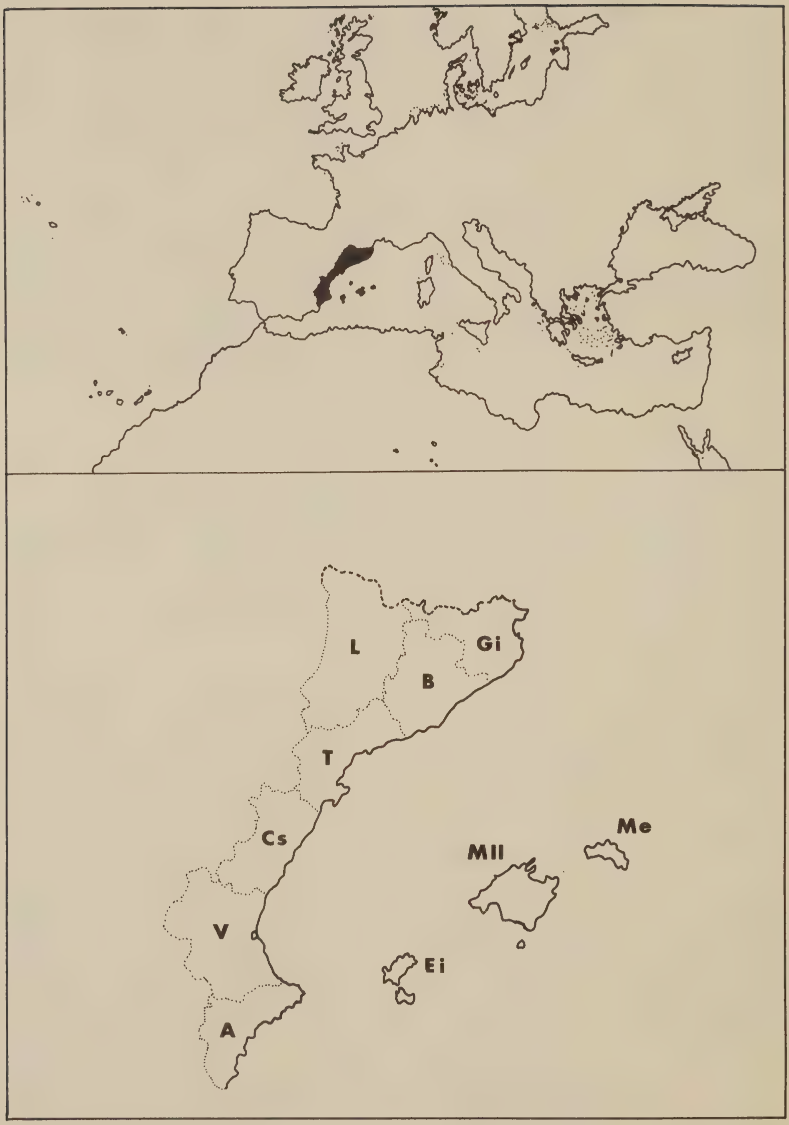

Fig. 1. The territory under study (BOLÒS, 1985) and provinces. A: Alacant, B: Barcelona, Cs: Castelló de la Plana, E: Eivissa, Gi: Girona, L: Lleida, Mll: Mallorca, Me: Menorca, V: València, T: Tarragona.

the literature are included.

Some sources are followed by one or two asterisks after the publication date. Those sources have not been consulted directly by us. We have drawn those data from the compilation of KNOCHE (1921) (with *) and of CODINA &FONT I QUER (1930) (with **).

The numbers in black are the remarks about taxonomy, systematics and ecology of some taxa.

After the references, the acronyms of the names of the provinces are listed in alphabetical order (Fig. 1).

CHECKLIST

Alpova Dodge

Alpova rubescens (Vitt.) Trappe – ROCABRUNA & TABARÉS (1991 a); TABARÉS & ROCABRUNA (1991); VIDAL et al. (1991) – Chorology: B.

Arachnion Schw.

Arachnion lloydianum Demoulin – CALONGE & DEMOULIN (1975)[1] – Chorology: B.

Astraeus Morg.

Astraeus hygrometricus (Pers.: Pers.) Morg. – COLMEIRO (1867)* as *Geaster hygrometricum* Pers.; VAYREDA (1882)** as *Astraeus stellatus* (Scop.) Fisch.; ROLLAND (1904) as *Geaster hygrometricus* P.; ARANZADI (1908) as *G. hygrometricus* Pers.; KNOCHE (1921) as *G. hygrometricus* Pers.; BOLÒS (1924) as *Astraeus stellatus* (Scop.) Fisch.; SOLÀ (1925) as *Geaster hygrometricus* Pers.; CODINA & FONT QUER (1930) as *Astraeus stellatus* (Scop.) Fisch.; PEARSON (1931); MAIRE et al. (1933); HEIM et al. (1934); MAUBLANC (1936); SINGER (1947); LLENSA (1968); LARSEN (1969); RIVAS MARTINEZ & LOSA QUINTANA (1969); MALENÇON & BERTAULT (1971 a); MALENÇON & BERTAULT (1971 b); CALONGE & DEMOULIN (1975); MALENÇON & BERTAULT (1976); FOLGADO (1983); LLIMONA (1983); BALLESTEROS (1984); FINSCHOW (1984); LLIMONA (1984); ROCABRUNA (1984); LLISTOSELLA & AGUASCA (1986); BARCELÓ (1986); AGUASCA & LLISTOSELLA (1987); TABARÉS & ROCABRUNA (1987); MARTíN (1988 a); ROCABRUNA & TABARÉS (1988); CALONGE et al. (1989); LLISTOSELLA & AGUASCA (1990); CALONGE (1990); CALONGE et al. (1991 a); CALONGE et al. (1991 b); ANGEL & PASCUAL (1991); VIDAL (1991 a); CALONGE et al. (1992) – Chorology: B, Ei, Gi, L, T, V.

Battarrea Pers.[2]

Battarrea phalloides Dicks.: Pers. – FREIXAS (1903)**; CODINA & FONT QUER (1930); AGUASCA & LLISTOSELLA (1987) as *Battarraea phalloides* Dicks.: Pers.; CALONGE et al. (1989) as *Battarraea phalloides* Dicks.: Pers.; CALONGE (1990) as *Battarraea phalloides* Dicks.: Pers.; LLISTOSELLA & AGUASCA (1990) as *Battarraea phalloides* Dicks.: Pers. – Chorology: B, Mll, Me.

Battarrea stevenii (Lib.) Fr.[3] – MAIRE et al. (1933) as *Battarraea Guicciardiniana* Ces.; CALONGE (1990) – Chorology: B.

Bovista Pers.: Pers.

Bovista aestivalis (Bon.) Demoulin – ROLLAND (1904) as *Lycoperdon furfuraceum* Schaeff.; KNOCHE (1921) as *L. furfuraceum* Schaeff.; SOLÀ (1925) as *L. furfuraceum* Schaeff.; CODINA & FONT QUER (1930) as *L. polymorphum* Vitt.; MAIRE et al. (1933) as *L. furfuraceum* Pers. ex Schaeff.; HEIM et al. (1934) as *L. furfuraceum* Pers. ex Schaeff.; MAUBLANC (1936) as *L. polymorphum* ; SINGER (1947) as *L. polymorphum* Vitt.; MALENÇON & BERTAULT (1971 a) as *L. furfuraceum* Schaeff. ex Vitt.;

MALENÇON & BERTAULT (1971 b) as *L. furfuraceum* Schaeff. ex Vitt.; CALONGE & DEMOULIN (1975) as *Bovista* sp.; LLISTOSELLA & AGUASCA (1986); JEPPSON (1987); TABARÉS & ROCABRUNA (1987); MARTÍN (1988 a); CALONGE & al. (1989); CALONGE (1990); CALONGE et al. (1991 a); CALONGE et al. (1991 b); ROCABRUNA & TABARÉS (1991); VIDAL (1991 a) – Chorology: B, Gi, L, Mll, T, V.

Bovista bovistoides (Cooke & Massee) Ahmad – CALONGE et al. (1991 a); CALONGE (1992) – Chorology: B.

Bovista cunninghamii Kreisel – CALONGE et al. (1991 b); CALONGE (1992) – Chorology: Me, Mll.

Bovista dermoxantha (Vitt.) de Toni[4] – FREIXAS (1903)** as *Lycoperdon pusillum* Batsch.; CODINA & FONT QUER (1930) as *L. pusillum* Batsch.; MAIRE et al. (1933) as *L. pusillum* Pers. ex Batsch.; LLISTOSELLA & AGUASCA (1986) as *Bovista pusilla* Batsch.: Pers.; MARTÍN (1988 a); CALONGE (1990) – Chorology: B, Gi, Mll.

Bovista graveolens K. Schwalb – JEPPSON (1987); MARTÍN (1988); ROCABRUNA & TABARÉS (1988); CALONGE (1990); CALONGE (1992) – Chorology: Gi.

Bovista limosa Rostr. – CALONGE & DEMOULIN (1975) – Chorology: Mll.

Bovista nigrescens Pers.: Pers. – MAIRE et al. (1933); HEIM et al. (1934); SINGER (1947); LLISTOSELLA & AGUASCA (1986); JEPPSON (1987); MARTÍN (1988 a); CALONGE (1990); ROCABRUNA & TABARÉS (1991 a) – Chorology: B, Gi, L.

Bovista paludosa Lév. – MARTÍN & VIDAL (1991); CALONGE (1992) – Chorology: L.

Bovista plumbea Pers.: Pers. – COLMEIRO (1867)*; FREIXAS (1903)**; CODINA & FONT QUER (1930); PEARSON (1931); MAIRE et al. (1933); HEIM et al. (1934); MAUBLANC (1936); MAIRE (1937); SINGER (1947); LLENSA (1968); MALENÇON & BERTAULT (1972); CALONGE & DEMOULIN (1975); LLISTOSELLA & AGUASCA (1986); AGUASCA & LLISTOSELLA (1987); TABARÉS & ROCABRUNA (1987); MARTÍN (1988 a); ROCABRUNA & TABARÉS (1988); CALONGE et al. (1989); TABARÉS & ROCABRUNA (1989); MARTÍN (1990); LLISTOSELLA & AGUASCA (1990); CALONGE (1990); VIDAL (1991 a); AGUASCA et al. (1992); CALONGE et al (1992) – Chorology: B, Gi, L, Me, Mll, T.

Bovista tomentosa (Vitt.) Quél. – LLISTOSELLA & AGUASCA (1986); JEPPSON (1987); CALONGE (1990) – Chorology: B, Gi.

Bovistella Morg.

Bovistella radicata (Dur. & Mont.) Pat. – MAUBLANC (1936) as *Lycoperdon radicatum*; CALONGE (1990) – Chorology: B, Gi.

Calvatia Fr.

Calvatia candida (Rostk.) Hollós – LLISTOSELLA & AGUASCA (1986); JEPPSON (1987); CALONGE (1990); VIDAL (1991 a) – Chorology: B.

Calvatia cyathiformis (Bosc.) Morg. – MAIRE et al. (1933) as *Calvatia fragilis* (Vitt.) Morg.; HEIM et al. (1934) as *C. lilacina* (Mont.) Lloyd; MALENÇON & BERTAULT (1971 a) as *C. lilacina* (Mont.) Lloyd ; ROCABRUNA (1984) as *C. lilacina* (Berk. et Mont.) Heim; MARTÍN (1988 a); ROCABRUNA & PASCUAL (1989); CALONGE (1990); ROCABRUNA & TABARÉS (1991 a); VIDAL (1991 a) – Chorology: B, Gi.

Calvatia excipuliformis (Pers.: Pers.) Perdeck – PEARSON (1931) as *Lycoperdon saccatum* Wahlenb.; MAIRE et al. (1933) as *Calvatia saccata* (Fr. ex Wahlenb.) Morgan; MAIRE (1937) as *C. saccata* (Fr. ex Wahlenb.) Morgan; SINGER (1947) as *C. saccata* (Fr. ex Wahlenb.) Morgan; CALONGE & DEMOULIN (1975) as *C. excipuliformis* (Scop. trans Pers., cum em) Perdeck; MARCHAND (1976) as *C. excipuliformis* (Scop. trans Pers., cum em) Perdeck; LOSA QUINTANA et al. (1980) as *Lycoperdon excipuliforme* (Scop. ex Pers.) em Perdeck; SIQUIER & CONSTANTINO (1982) as *L. excipuliformis* Scop.; LLISTOSELLA & AGUASCA (1986) as *Calvatia excipuliformis* (Schaeff.: Pers.) Perdeck; AGUASCA & LLISTOSELLA (1987) as *C. excipuliformis* (Schaeff.: Pers.) Perdeck; MARTÍN (1988 a) as *C. excipuliformis* (Scop.: Pers.) Perdeck; CALONGE et al (1989) as

C. excipufiformis (Scop.: Pers.) Perdeck; MARTíN (1990) as *C. excipuliformis* (Scop.: Pers.) Perdeck; LLISTOSELLA & AGUASCA (1990) as *C. excipuliformis* (Schaeff.: Pers.) Perdeck; CALONGE (1990) as *C. excipuliformis* (Scop.: Pers.) Perdeck; VIDAL (1991 a) as *C. excipuliformis* (Scop.: Pers.) Perdeck; AGUASCA et al. (1992) as *C. excipuliformis* (Scop.: Pers.) Perdeck; CALONGE et al (1992) as *C. excipuliformis* (Schaeff.: Pers.) Perdeck – Chorology: B, Gi, L, Mll.

Calvatia utriformis (Bull.: Pers.) Jaap – ARANZADI (1908) as *Lycoperdon caelatum* Bull.; CODINA & FONT QUER (1930) as *L. caelatum* Bull.; MAIRE et al. (1933) as *Calvatia Bovista* Pers. ex L.; SINGER (1947) as *C. bovista* (L.) Pers.; MALENÇON & BERTAULT (1971 b) as *C. caelata* (Bull. ex Pers.) Morg.; CALONGE & DEMOULIN (1975); LOSA QUINTANA et al. (1980) as *C. caelata* Fr.; LLIMONA (1983); ROCABRUNA (1984); BALLESTEROS (1984) as *C. caelata* (Bull.) Morg.; ROCABRUNA et al. (1984); DIEZ et al. (1986) as *Lycoperdon caelatum* (Bull.) Morg.; TABARÉS & ROCABRUNA (1987); MARTíN (1987); MARTíN (1988 a); ROCABRUNA & TABARÉS (1988); CALONGE (1990); VIDAL (1991) – Chorology: B, Gi, L.

Clathrus Pers.

Clathrus ruber Pers.: Pers. – CAMBESSEDES (1827)*; COLMEIRO (1867)*; BARCELÓ–COMBIS (1879–1881)* as *Clathrus cancellatus* L.; ROLLAND (1904) as *C. cancellatus* L.; ARANZADI (1905) as *C. cancellatus* Tourn. : Fr.; KNOCHE (1921) as *C. cancellatus* L (?) Tournefort; BOLÒS (1924) as *C. cancellatus* L.; SOLÀ (1925) as *C. cancellatus* Tourn.: Fr.; CODINA & FONT QUER (1930) as *C. cancellatus* L.; PEARSON (1931) as *C. cancellatus* Tourn. : Fr.; MAIRE et al. (1933); HEIM et al. (1934); MAUBLANC (1936) as *C. cancellatus*; MAIRE (1937); ORELL (1961); LARSEN (1969); BERTAUX (1964); LLENSA (1968) as *C. cancellatus*; MALENÇON & BERTAULT (1971 a); MALENÇON & BERTAULT (1971 b); CALONGE & DEMOULIN (1975); MARCHAND (1976); BERTAULT (1982); FAUS et al. (1982); LLIMONA (1983); BALLESTEROS (1984); FINSCHOW (1984); ROCABRUNA (1984); DIEZ et al. (1986); BARCELÓ (1986); AGUASCA & LLISTOSELLA (1987); MARTíN (1987); TABARÉS & ROCABRUNA (1987); MARTíN (1988 a); ROCABRUNA & TABARÉS (1988); CALONGE et al. (1989); CALONGE (1990); VIDAL (1991 a); AGUASCA et al. (1992) – Chorology: B, Ei, Gi, Mll, T.

Colus Cav. & Séch.

Colus hirudinosus Cav. & Séch. – CODINA (1932); MAIRE et al. (1933); AGUASCA & LLISTOSELLA (1987); MARTíN (1988 a); CALONGE et al. (1989); CALONGE (1990); VIDAL & PASCUAL (1990); CALONGE et al. (1991 b); VIDAL (1991 a); AGUASCA et al. (1992) – Chorology: B, Gi, Mll, V.

Crucibulum Tul.

Crucibulum laeve (Huds.) Kambly – BARNOLA (1903); ARANZADI (1908) as *Crucibulum vulgare* Tul.; BOLÒS (1924) as *C. vulgare* Tul.; CODINA & FONT QUER (1930) as *C. vulgare* Tul.; PEARSON (1931) as *C. vulgare* Tul.; MAIRE et al. (1933) as *C. vulgare* Tul.; HEIM et al. (1934) as *C. vulgare* Tul.; MAUBLANC (1936) as *C. vulgare* Tul.; SINGER (1947) as *C. vulgare* Tul. CALONGE & DEMOULIN (1975); BALLESTEROS (1984) as *C. laeve* (Bull. ex DC) Kambly; LLIMONA (1984); ROCABRUNA (1984) as *C. laeve* Bull. ex DC; BARCELÓ (1986) as *C. laeve* (Bull. ex DC) Kambly ; LLISTOSELLA & AGUASCA (1986); TABARÉS & ROCABRUNA (1987) as *C. laeve* (Bull. ex DC) Kambly; MARTíN (1988 a); ROCABRUNA & TABARÉS (1988) as *C. laeve* (Bull. ex DC) Kambly; CALONGE et al. (1989); CALONGE (1990); VIDAL (1991 a) – Chorology: B, Gi, L, Mll.

Cyathus Haller: Pers.

Cyathus olla (Batsch : Pers.) Pers. – BARCELÓ–COMBIS (1879–1881)* as *Cyathus vernicosus* DC; COLMEIRO (1889)*; ROLLAND (1904) as *C. vernicosus* B.; ARANZADI (1908) as *C. vernicosus* B.; KNOCHE (1921) as *C. vernicosus* B.; CODINA & FONT

QUER (1930); HEIM et al. (1934) as *C. sericeus* Schaeff.; MAIRE (1937); CALONGE & DEMOULIN (1975); HONRUBIA et al. (1982); FINSCHOW (1984); ROCABRUNA (1984); LLISTOSELLA & AGUASCA (1986); FOLGADO et al. (1984); AGUASCA & LLISTOSELLA (1987); MARTíN (1988 a); ROCABRUNA & TABARÉS (1988); CALONGE et al. (1989); CALONGE (1990); VIDAL (1991 a); AGUASCA et al. (1992) – Chorology: A, B, Ei, Gi, L, Mll, T.

Cyathus stercoreus (Schw.) de Toni – CODINA & FONT QUER (1930); MARTíN (1988 a); CALONGE (1990); CALONGE et al. (1991 a) – Chorology: B, Gi.

Cyathus striatus (Huds. : Pers.) Willd. : Pers. – CODINA & FONT QUER (1930); HEIM et al. (1934) as *Cyathus hirsutus* Schaeff.; MAIRE (1937); SINGER (1947); BERTAULT (1982); ROCABRUNA (1984); BALLESTEROS (1984); ROCABRUNA et al. (1985); LLISTOSELLA & AGUASCA (1986); MARTíN (1987); MARTíN (1988 a); ROCABRUNA & TABARÉS (1988); CALONGE et al. (1989); CALONGE (1990); CALONGE et al. (1991 a); VIDAL (1991 a) – Chorology: B, Gi, L, Mll, V, T.

Disciseda Czernajev

Disciseda bovista (Klotz.) P. Henn. – CODINA & FONT QUER (1930) as *Lycoperdon defossum* Vitt.; MAIRE et al. (1933) as *L. defossum* Vitt.; JEPPSON (1987); CALONGE (1990); ROCABRUNA & TABARÉS (1991 b); TABARÉS & ROCABRUNA (1991) – Chorology: B.

Disciseda candida (Schw.) Lloyd – MALENÇON & BERTAULT (1971 a); JEPPSON (1987); MARTíN (1988 a); CALONGE (1990) as *Disciseda calva* (Moravec) Moravec; ROCABRUNA & TABARÉS (1991 b) as *Disciseda calva* (Moravec) Moravec; VIDAL (1991 a) as *Disciseda calva* (Moravec) Moravec – Chorology: B, Gi.

Endoptychum Czernajev

Endoptychum agaricoides Czernajev – ROCABRUNA (1984); MARTíN (1987); ROCABRUNA & PASCUAL (1987); MARTíN (1988 a) – Chorology: B.

Galeropsis Singer

Galeropsis lateritia (Watling) Moreno et al.[5] – WATLING et al. (1986) as *Gastrocybe lateritia* Watling; TABARÉS et al. as *G. lateritia* Watling; TABARÉS & PASCUAL (1986) as *G. lateritia* Watling; CALONGE (1990) – Chorology: B.

Gastropila Homrich & Wright

Gastropila fragilis (Lév.) Homrich & Wright – DEMOULIN et al. (1988) as *Calvatia pachyderma* (Peck.) Lloyd; CALONGE (1990); CALONGE & MARTíN (1990) – Chorology: Gi.

Gastrosporium Mattir.

Gastrosporium simplex Mattir. – MALENÇON & BERTAULT (1971 a) – Chorology: V.

Gautieria Vitt.

Gautieria morchelliformis Vitt.[6] – CALONGE et al. (1977); AYMERICH & LLIMONA (1986); CALONGE (1990) – Chorology: B, L.

Geastrum Pers.

Geastrum badium Pers. – CODINA & FONT QUER (1930) as *Geastrum ambiguus* Mont.; VIDAL (1987); MARTíN (1988 a); MARTíN (1988 b); ROCABRUNA & TABARÉS (1988); CALONGE (1990); VIDAL & PASCUAL (1990) as *G. umbilicatum* A.H. Smith; CALONGE et al. (1991 a) – Chorology: B, Gi.

Geastrum campestre Morg. – CALONGE (1984); MARTíN (1988); CALONGE (1990); TABARÉS & ROCABRUNA (1991) – Chorology: B, Gi.

Geastrum corollinum (Bastch) Hollós[7] – FREIXAS (1903)** as *Geaster mammosus* (Chev.) Fr.; CODINA & FONT QUER (1930) as *G. mammosum* Chev.; VIDAL (1987) as

Geastrum recolligens (Woodw. ex Sow.) Desv.; CALONGE (1990) as *G. recolligens* (Woodw. ex Sow.) Desv. – Chorology: B, Gi.

Geastrum floriforme Vitt. – MALENÇON & BERTAULT (1972) as *Geaster floriformis* Vitt.; CALONGE (1990) – Chorology: Me.

Geastrum fornicatum (Huds.) Hooker – VIDAL (1987) as *Geastrum fornicatum* (Huds. : Pers.) Hooker; CALONGE (1990) as *Geastrum fornicatum* (Huds. ex Winch. et al.) Hooker – Chorology: Gi.

Geastrum lageniforme Vitt. – VIDAL (1987); CALONGE (1990) – Chorology: Gi.

Geastrum minimun Schw. – CALONGE & DEMOULIN (1975); FINSCHOW (1984); LLISTOSELLA & AGUASCA (1986); JEPPSON (1987); TABARÉS & ROCABRUNA (1987); VIDAL (1987); MARTÍN (1988 a); CALONGE (1990) – Chorology: B, Ei, Gi.

Geastrum morganii Lloyd – VIDAL (1987); CALONGE (1990) – Chorology: Gi.

Geastrum nanum Pers.[8] – CODINA & FONT QUER (1930) as *Geaster Schimidelli* Vitt.; MAIRE et al. (1933) as *G. nanus* Pers.; HEIM et al. (1934) as *G. nanus* Pers.; MAUBLANC (1936) as *G. nanus* ; CALONGE & DEMOULIN (1975); VIDAL (1987); MARTÍN (1988 a); MARTÍN (1988); CALONGE (1990); CALONGE et al. (1991 b) – Chorology: B, Gi, L, Mll.

Geastrum pectinatum Pers.: Pers. – LLIMONA (1984) as *Geastrum pectinatum*; AGUASCA & LLISTOSELLA (1987); VIDAL (1987); MARTÍN (1987); CALONGE et al. (1989); LLISTOSELLA & AGUASCA (1990); CALONGE (1990); ROCABRUNA & TABARÉS (1991 a); TABARÉS & ROCABRUNA (1991) – Chorolology: B, Gi, Mll.

Geastrum quadrifidum Pers.: Pers. – MAIRE et al. (1933) as *Geaster Queletti* Hazsl.; MARTÍN (1988 a); CALONGE (1990); CALONGE et al. (1991 b); ROCABRUNA & TABARÉS (1991 a) – Chorology: B, Mll.

Geastrum rufescens Pers.: Pers.[9] – CAMBESSEDES (1827)* as *Geastrum vulgatum* Vitt.; COLMEIRO (1867)* as *G. vulgatum* Vitt.; BARCELÓ – COMBÍS (1879 – 1881)*; ROLLAND (1904); KNOCHE (1921); CODINA & FONT QUER (1930); MAIRE et al. (1933); HEIM et al. (1934); LARSEN (1969); CALONGE & DEMOULIN (1975) as *G. vulgatum* Vitt.; LOSA QUINTANA & al. (1980); CALONGE (1984); LLIMONA (1984) ; LLISTOSELLA & AGUASCA (1986) as *G. vulgatum* Vitt.; AGUASCA & LLISTOSELLA (1987) as *G. vulgatum* Vitt.; MARTÍN (1988 a) as *G. vulgatum* Vitt.; CALONGE et al. (1989) as *G. vulgatum* Vitt.; CALONGE (1990); LLISTOSELLA & AGUASCA (1990) as *G. vulgatum* Vitt. – Chorology: B, Gi, L, Mll, T.

Geastrum saccatum (Fr.) E. Fisch. – CALONGE (1981); VIDAL (1987); MARTÍN (1988 a); CALONGE et al. (1989); CALONGE (1990) – Chorology: Gi, L, Mll, T.

Geastrum saccatum Fr. forma parvulum Boiffard – VIDAL (1987) – Chorology: Gi.

Geastrum striatum DC – CALONGE (1990) – Chorology: Gi.

Geastrum triplex Jungh. – ROLLAND (1904); LARSEN (1969); LLISTOSELLA & AGUASCA (1986); DIEZ et al. (1986); AGUASCA & LLISTOSELLA (1987); MARTÍN (1987); TABARÉS & PASCUAL (1987); TABARÉS & ROCABRUNA (1987); VIDAL (1987); MARTÍN (1988 a); CALONGE et al. (1989); LLISTOSELLA & AGUASCA (1990); CALONGE (1990); CALONGE et al. (1991 a) – Chorology: B, Gi, Mll.

Geastrum tunicatum Vitt. – MAIRE et al. (1933) as *Geaster fimbriatus* Fr.; HEIM et al. (1934) as *G. fimbriatus* Fr.; MAUBLANC (1936) as *G. fimbriatus* Fr.; MAIRE (1937) as *G. fimbriatus* Fr.; SINGER (1947) as *G. fimbriatus* Fr.; ORELL (1961) as *G. fimbriatus* Fr.; BERTAUX (1964) as *G. fimbriatus* Fr.; LLENSA (1970) as *G. fimbriatus* Fr.; CALONGE & DEMOULIN (1975) as *Geastrum sessile* (Sow.) Pouzar; MALENÇON & LLIMONA (1983) as *G. fimbriatum* Fr.; BARCELÓ (1986) as *G. sessile* (Sow.) Pouzar; DIEZ et al. (1986) as *Geaster fimbriatus* Fr.; LLISTOSELLA & AGUASCA (1986) as *Geastrum sessile* (Sow.) Pouzar; TABARÉS & ROCABRUNA (1987) as *G. sessile* (Sow.) Pouzar; VIDAL (1987) as *G. sessile* (Sow.) Pouzar; MARTÍN (1988 a) as *G. fimbriatum* (Fr.) Fisch.; ROCABRUNA & TABARÉS (1988) as *G. fimbriatum* (Fr.) Fisch.; CALONGE et al. (1989) as *G. fimbriatum* (Fr.) Fisch.; CALONGE (1990) as *G.*

fimbriatum (Fr.) Fisch.; CALONGE et al. (1991 a) as *G. fimbriatum* (Fr.) Fisch.; ROCABRUNA & TABARÉS (1991 b) as *G. fimbriatum* (Fr.) Fisch. – Chorology: A, B, Gi, L, Mll.

Gyrophragmium Mont.
Gyrophragmium dunalii (Fr.) Zeller – CODINA & FONT QUER (1930) as *Gyrophragmium delilei* Mont.; HEIM et al. (1934) as *G. delilei* Mont.; CALONGE & DEMOULIN (1975); MALENÇON & BERTAULT (1976) as *G. delilei* Mont.; HONRUBIA et al. (1982); FOLGADO et al. (1984); MARTÍN (1988 a); CALONGE (1990) – Chorology: B, T.

Hydnangium Wallr.
Hydnangium aurantiacum Heim et Malençon – HEIM et al. (1934); CALONGE (1990)[10]; VIDAL & PASCUAL (1991); VIDAL (1991 b) – Chorology: B, Gi.
Hydnangium carneum Wallr. – VIDAL & PASCUAL (1987); MARTÍN & VIDAL (1988); CALONGE (1990); VIDAL (1991 b) – Chorology: Gi.
Hydnangium pila Pat. – HEIM et al. (1934) – Chorology: Gi.

Hymenogaster Vitt.
Hymenogaster arenarius Tul. – VIDAL (1991 b) – Chorology: Gi.
Hymenogaster bulliardii Vitt. – VIDAL (1991 b) – Chorology: Gi.
Hymenogaster citrinus Vitt. – HEIM et al. (1934); CALONGE (1990); VIDAL (1991 b); ALVAREZ et al. (1993) – Chorology: B, Gi.
Hymenogaster hessei Soehner. – VIDAL (1991 b); MARTÍN et al. (1993) – Chorology: B, Gi.
Hymenogaster luteus Vitt. – FINSCHOW (1984); VIDAL & PASCUAL (1991); VIDAL (1991 b) – Chorology: Ei, Gi.
Hymenogaster muticus Berk. & Br. – ALVAREZ et al. (1993) – Chorology: Gi.
Hymenogaster olivaceus Vitt. – HEIM et al. (1934) as *Himenogaster calosporus* Tul.; CALONGE (1990); TABARÉS & ROCABRUNA (1991); VIDAL (1991 b) – Chorology: B, Gi.
Hymenogaster populetorum Tul. – CALONGE et al. (1985); CALONGE (1990) – Chorology: B.
Hymenogaster rehsteineri Bucholtz – VIDAL (1991 b) – Chorology: Gi.
Hymenogaster thwaitesii Berk. – VIDAL (1991 b) – Chorology: Gi.
Hymenogaster vulgaris Tul. – HEIM et al. (1934); CALONGE et al. (1985); CALONGE (1990) – Chorology: B.

Hysterangium Vitt.
Hysterangium coriaceum R. Hesse[11] – ROCABRUNA & TABARÉS (1991 a) as *Hysterangium separabile* Zeller; VIDAL et al. (1991) as *H. separabile* Zeller – Chorology: B, Gi.
Hysterangium inflatum Rodw. – CALONGE & VIDAL (1989); VIDAL & PASCUAL (1989); CALONGE (1990); VIDAL (1991 b) – Chorology: Gi.
Hysterangium rickenii Soehner – VIDAL & PASCUAL (1991); VIDAL (1991 b); MARTÍN et al. (1993) – Chorology: B, Gi.
Hysterangium stoloniferum Tul. var rubescens (Quél.) Zeller & Dodge – VIDAL (1991 b); MARTÍN et al. (1993) – Chorology: B, Gi.

Ileodictyon Tul.
Ileodictyon gracile Berk. – MARTÍN & VIDAL (1991); VIDAL (1991 a) – Chorology: B, Gi.

Langermannia Rostk.
Langermannia gigantea (Batsch. : Pers.) Rostk. – COLMEIRO (1867)* as *Bovista gigantea* Nees; BARCELÓ-COMBIS (1879-1881)* as *B. gigantea* Nees; VAYREDA

(1882)** as *Lycoperdon maximum* Schaeff.; MASFERRER (1887)** as *L. maximum* Schaeff.; KNOCHE (1921) as *L. bovista* L.; CODINA & FONT QUER (1930) as *L. maximum* Schaeff.; MAIRE et al. (1933) as *Calvatia gigantea* (Pers.) LLoyd; LLENSA (1968) as *Bovista gigantea* ; LLENSA (1970) as *B. gigantea* Batsch.; MARTíN (1988 a); CALONGE et al. (1989); CALONGE (1990); VIDAL & PASCUAL (1991); VIDAL (1991 c) - Chorology: B, Gi, Mll, V, T.

Leucogaster Hesse

Leucogaster tozzianus (Cav. et Sacc.) Matt. apud Zeller & Dodge.- MARTíN et al. (1993) - Chorology: B, T.

Lycoperdon Tourn. ex Pers.: Pers.

Lycoperdon atropurpureum Vitt.- ARANZADI (1908); CODINA & FONT QUER (1930); MALENÇON & BERTAULT (1972); CALONGE & DEMOULIN (1975); LLISTOSELLA & AGUASCA (1986); JEPPSON (1987); CALONGE et al. (1989); CALONGE (1990)[12]; CALONGE et al. (1991 b); VIDAL (1991 a)[12] - Chorology: B, Gi, Me, Mll.

Lycoperdon decipiens Dur. et Mont. - CALONGE & DEMOULIN (1975); LLIMONA (1983); LLISTOSELLA & AGUASCA (1986); JEPPSON (1987) - Chorology: B, Gi.

Lycoperdon echinatum Pers.: Pers. - BARCELÓ-COMBIS (1879-1881)*; MASFERRER (1887)**; COLMEIRO (1889)*; ROLLAND (1904); KNOCHE (1921); CODINA & FONT QUER (1930); HEIM et al.(1934); MAIRE (1937); SINGER (1947); FONT QUER (1954); LLENSA (1968); MALENÇON & BERTAULT (1971 b); POLO (1982); ROCABRUNA et al. (1983); ROCABRUNA (1984); BALLESTEROS (1984); BARCELÓ (1986); DIEZ et al. (1986); MARTíN (1987); MARTíN (1988 a) a; ROCABRUNA & TABARÉS (1988); CALONGE et al. (1989); CALONGE (1990); VIDAL (1991 a) - Chorology: B, Gi, L, Mll, T, V.

Lycoperdon ericaeum Bonord. - MARTíN (1988 a); CALONGE (1990); VIDAL (1991 a) - Chorology: B, Gi.

Lycoperdon lambinonii Demoulin - LLISTOSELLA & AGUASCA (1986); JEPPSON (1987); MARTíN (1988 a); CALONGE (1990); TABARÉS & ROCABRUNA (1991) - Chorology: B, Gi, L.

Lycoperdon lividum Pers. - MALENÇON & BERTAULT (1971 a) as *Lycoperdon spadiceum* Pers. ss Hollós; CALONGE & DEMOULIN (1975); BERTAULT (1982) as *L. spadiceum* Pers.; LLISTOSELLA & AGUASCA (1986); MARTíN (1988 a); CALONGE (1990); CALONGE et al. (1991 b); VIDAL (1991 a) - Chorology: B, Gi, L, Mll.

Lycoperdon mammiforme Pers. - MAIRE et al. (1933) as *Lycoperdon velatum* Vitt.; HEIM et al. (1934) as *L. velatum* Vitt.; MAUBLANC (1936) as *L. velatum* Vitt.; MAIRE (1937) as *L. velatum* Vitt.; MALENÇON & BERTAULT (1971 a); MALENÇON & BERTAULT (1971 b); MARTíN (1988 a); ROCABRUNA & TABARÉS (1988); VIDAL & PASCUAL (1989); CALONGE (1990); VIDAL (1991 a) - Chorology: B, Gi, T.

Lycoperdon marginatum Vitt. ex Moris et De Not. - MAIRE et al. (1933); MAIRE (1937); CALONGE & DEMOULIN (1975); JEPPSON (1987); MARTíN (1988 a); MARTíN (1988); VIDAL & PASCUAL (1988); CALONGE (1990); VIDAL (1991 a) - Chorology: B, Gi.

Lycoperdon molle Pers. : Pers. - MALENÇON & BERTAULT (1971 a); MALENÇON & BERTAULT (1971 b); CALONGE & DEMOULIN (1975); MALENÇON & BERTAULT (1976); MARCHAND (1976); LOSA QUINTANA et al. (1980); SIQUIER & CONSTANTINO (1982); LLIMONA (1984) as *Lycoperdon* cf. *molle*; ROCABRUNA (1984); BARCELÓ (1986); LLISTOSELLA & AGUASCA (1986); JEPPSON (1987); MARTíN (1988 a); CALONGE et al. (1989); CALONGE (1990); CALONGE et al. (1991 a); VIDAL (1991 a) - Chorology: B, Gi, L, Mll, T.

Lycoperdon nigrescens Pers. - LLISTOSELLA & AGUASCA (1986) as *Lycoperdon foetidum* Bonord.; JEPPSON (1987) as *L. nigrescens* Pers.: Pers.; MARTíN (1988 a) as *L. foetidum* Bonord.; CALONGE (1990) as *L. nigrescens* Pers.: Pers. - Chorology: B, Gi.

Lycoperdon perlatum Pers. : Pers. – CAMBESSEDES (1827)*; COLMEIRO (1867)*; ROLLAND (1904) as *Lycoperdon* Tourn. *gemmatum* Batsch.; KNOCHE (1921) as *L. gemmatum* Batsch.; SOLÀ (1925) as *L. gemmatum* Fr.; CODINA & FONT QUER (1930) as *L. gemmatum* Batsch.; PEARSON (1931); MAIRE et al. (1933); HEIM et al.(1934); MAUBLANC (1936) as *L. gemmatum*; FONT QUER (1954); BERTAUX (1964) as *L. perlatum* ; LLENSA (1968) as *L. gemmatum* Batsch.; LARSEN (1969); LLENSA (1970) as *L. gemmatum* Batsch.; MALENÇON & BERTAULT (1971 a) as *L. gemmatum* Fr.; MALENÇON & BERTAULT (1971 b) as *L. gemmatum* Fr.; LASUNCIÓN et al. (1974); CALONGE & DEMOULIN (1975); LOSA QUINTANA et al. (1980); BERTAULT (1982); POLO (1982); ROCABRUNA et al. (1982); LLIMONA (1983); MALENÇON & LLIMONA (1983); BALLESTEROS (1984); LLIMONA (1984) as *L. perlatum*; ROCABRUNA (1984); BARCELÓ (1986); DIEZ (1986); LLISTOSELLA & AGUASCA (1986); AGUASCA & LLISTOSELLA (1987); MARTíN (1987); TABARÉS & ROCABRUNA (1987); MARTíN (1988 a); CALONGE et al. (1989); CALONGE (1990); LLISTOSELLA & AGUASCA (1990); CALONGE et al. (1991 a); CALONGE et al. (1991 b); VIDAL (1991 a); AGUASCA et al. (1992); CALONGE et al. (1992) – Chorology: A, B, Gi, L, Mll, T.

Lycoperdon pyriforme Schaeff. : Pers. – COLMEIRO (1867)* as *Lycoperdon pyriforme* Bull.; SOLÀ (1925); CODINA & FONT QUER (1930); PEARSON (1931); MAIRE et al. (1933); HEIM et al. (1934); MAUBLANC (1936) as *L. piriforme*; MAIRE (1937); SINGER (1947); BERTAUX (1964) as *L. piriforme*; LLENSA (1968); LLENSA (1970); LOSA QUINTANA et al. (1980); GIRBAL (1986); LLISTOSELLA & AGUASCA (1986); ROCABRUNA (1986); ROCABRUNA & PASCUAL (1986) as L. piriforme Schaeff. ex Pers.; AGUASCA & LLISTOSELLA (1987); JEPPSON (1987); MARTíN (1987); MARTíN (1988 a); ROCABRUNA & TABARES (1988); CALONGE et al. (1989); LLISTOSELLA & AGUASCA (1990); CALONGE (1990) – Chorology: B, Gi, L, Mll, V.

Lycoperdon rimulatum Peck. – CALONGE (1990)[13] – Chorology: B.

Lycoperdon umbrinum Pers.: Pers. – ARANZADI (1908); MAIRE et al. (1933); HEIM et al. (1934); MAUBLANC (1936); MAIRE (1937); BERTAULT (1982); LLIMONA (1984); BALLESTEROS (1984); JEPPSON (1987); MARTíN (1988 a); CALONGE (1990); CALONGE et al. (1991 b); VIDAL (1991 a) – Chorology: B, Gi, L, Mll, T.

Lysurus Fr.

Lysurus mokusin (L. : Pers.) Fr. – MARTíN & VIDAL (1991) as *Lysurus mokusin* (Cibot : Pers.) Fr – Chorology: Gi.

Martellia Matt.

Martellia pila (Pat.) J.M.Vidal – TABARÉS & ROCABRUNA (1991); VIDAL (1991 b) – Chorology: B, Gi.

Melanogaster Corda

Melanogaster ambiguus (Vitt.) Tul. – CALONGE (1982); MARTíN (1988); ROCABRUNA & TABARÉS (1988); CALONGE (1990); VIDAL (1991 b); ALVAREZ et al. (1993) – Chorology: B, Gi.

Melanogaster macrosporus Velen. – VIDAL et al. (1991) – Chorology: Gi.

Melanogaster variegatus (Vitt.) Tul s.l[14] – MAIRE (1937) as *Melanogaster variegatus* (Vitt.) Tul. var. *broomeianus* (Berk.) Tul.; SINGER (1947) as *M. variegatus* (Vitt.) Tul. var. *broomeianus* (Berk.) Tul.; CALONGE et al. (1985) as *M. broomeianus* Berk.; LLISTOSELLA & AGUASCA (1986); MARTíN (1988 a) as *M. broomeianus* Berk.; CALONGE et al. (1989); CALONGE et al. (1989) as *M. broomeianus* Berk.; CALONGE (1990); CALONGE (1990) as *M. broomeianus* Berk.; TABARÉS & ROCABRUNA (1991); VIDAL (1991 b); ALVAREZ et al. (1993) as *M. broomeianus* Berk. – Chorology: B, Gi, Mll, T.

Montagnea Fr.
Montagnea arenaria (DC.) Zeller – RIVAS MARTINEZ & LOSA QUINTANA (1969) as *Montagnites candollei* Fr.; HONRUBIA et al. (1982); FOLGADO (1983); FOLGADO et al. (1984); CALONGE (1990) – Chorology: A, B, Cs, Gi, V.

Mutinus Fr.
Mutinus caninus (Huds. : Pers.) Fr. – CODINA & FONT QUER (1930); MAIRE (1937); CALONGE & DEMOULIN (1975); MARTíNEZ DE TABARÉS et al. (1983); ROCABRUNA (1984); MARTíN (1987); MARTíN (1988 a); ROCABRUNA & TABARÉS (1988); CALONGE (1990); CALONGE et al. (1991 a); VIDAL (1991 a) – Chorology: B, Gi.

Mycocalia J.T. Palmer
Mycocalia duriaeana (Tul.) J.T. Palmer – VIDAL (1991 a) – Chorology: Gi.

Myriostoma Desv.
Myriostoma coliforme (Dicks. : Pers.) Corda – VIDAL (1987); MARTíN (1988 a); MARTíN (1988); VIDAL & PASCUAL (1988); CALONGE (1990); TABARÉS & ROCABRUNA (1991) – Chorology: B, Gi.

Octavianina O. Kuntze
Octavianina pila (Pat.) Svrček – CALONGE (1990); VIDAL & PASCUAL (1991) – Chorology: Gi.
Octavianina asterosperma Vitt. – MARTíN et al. (1993) – Chorology: B, T.

Phallogaster Morg.
Phallogaster saccatus Morg. – CALONGE et al. (1992) – Chorology: B.

Phallus Hadr. Junius ex Pers.
Phallus duplicatus Bosc. – PALAU (1947) as *Dictyophora duplicata* (Bosc.) E. Fisch.; MALENÇON & BERTAULT (1971 a) as *D. duplicata* (Bosc.) E. Fisch. var. *obliterata* Malençon; CALONGE (1990) – Chorology: B.
Phallus hadriani Vent. : Pers. – HEIM et al. (1934) as *Phallus imperialis* (Schulz.) Fr.; MALENÇON & BERTAULT (1971 a) as *P. imperialis* (Schulz.) Fr.; MARTíN (1988 a); MARTíN (1988); ROCABRUNA & PASCUAL (1988); CALONGE (1990) – Chorology: B, Gi, V.
Phallus impudicus L.: Pers. – COLMEIRO (1867)*; BARCELÓ–COMBIS (1879–1881)*; BOFILL (1880)**; MASFERRER (1887)**; ROLLAND (1904); ARANZADI (1905); KNOCHE (1921) as *Ithyphallus impudicus* Fr.; BOLÒS (1924); SOLÀ (1925); CODINA & FONT QUER (1930); HEIM et al. (1934) as *I. impudicus* (Pers. ex L.) Fr.; MAUBLANC (1936) as *Phallus impudicus*; MAIRE (1937); BERTAUX (1964) as *Ithyphallus impudicus*; LLENSA (1968) as *Phallus impudicus* L.: Fr.; LLENSA (1970) as *P. impudicus* Fr.; MALENÇON & BERTAULT (1971 b); LOSA QUINTANA et al. (1980); LLIMONA (1983); ROCABRUNA et al. (1983); FINSCHOW (1984); ROCABRUNA (1984); DIEZ (1968) as *P. impudicus* L.: Fr.; LLISTOSELLA & AGUASCA (1986); MARTíN (1987); MARTíN (1988 a); ROCABRUNA & TABARÉS (1988); CALONGE et al. (1989); CALONGE (1990); VIDAL (1991 a); AGUASCA et al. (1992); CALONGE et al. (1992) – Chorology: B, Ei, Gi, L, Mll.

Pisolithus Alb. et Schw.
Pisolithus arhizus (Scop.: Pers.) Rauschert[15] – SOLÀ (1925) as *Pisolithus arenarius* Alb. et Schw. ; CODINA & FONT QUER (1930) as *P. arenarius* Alb. et Schw.; MAIRE et al. (1933) as *P. arenarius* Alb. et Schw.; HEIM et al. (1934) as *P. arenarius* Alb. et Schw.; SINGER (1947) as *P. arenarius* Alb. et Schw.; BERTAUX (1964) as *P. arenarius* Alb. et Schw.; LARSEN (1969) as *P. tinctorius* (Pers.) Coker & Couch; MALENÇON & BERTAULT (1971 a) as *P. tinctorius* (Pers.) Coker & Couch; CALONGE & DEMOULIN

(1975) as *Pisolithus arhizus* (Scop.: Pers.) Rauschert; MALENÇON & BERTAULT (1976) as *P. tinctorius* (Pers.) Coker & Couch; LLIMONA (1984); ROCABRUNA (1984); AGUASCA & LLISTOSELLA (1987); MARTíN (1988 a); ROCABRUNA & TABARÉS (1988); CALONGE et al. (1989); CALONGE (1990); VIDAL (1991 a) – Chorology: B, Gi, L. T.

Rhizopogon Fr.

Rhizopogon luteolus Fr. et Nordh. – ROLLAND (1904); KNOCHE (1921); MAIRE et al. (1933); MAIRE (1937); LLIMONA (1983); LLIMONA (1984); BALLESTEROS (1984); DIEZ (1986); BARCELÓ (1986); MARTíN (1988 a); ROCABRUNA & TABARÉS (1988); CALONGE et al. (1989); CALONGE (1990); VIDAL (1991 b); ALVAREZ et al. (1993) – Chorology: B, Gi, L, Mll, T.

Rhizopogon roseolus (Corda) Th. M. Fr. – CODINA & FONT QUER (1930) as *Rhizopogon rubescens* Tul.; MAIRE et al. (1933) as *R. aestivus* Fr. ex Wuff.; MAUBLANC (1936) as *R. rubescens*; MAIRE (1937) as *R. aestivus* Fr. ex Wuff.; SINGER (1947); FONT QUER (1954) as *R. rubescens* Tul.; LLENSA (1970) as *R. rubescens* Tul.; MALENÇON & BERTAULT (1972); CALONGE & DEMOULIN (1975); HONRUBIA et al. (1982); LLIMONA (1983); FINSCHOW (1984); LLIMONA (1984) as *R. rubescens*; ROCABRUNA (1984); DIEZ et al. (1986) as *R. rubescens* Tul.; BARCELÓ (1986) as *R. rubescens*; TABARÉS & ROCABRUNA (1987); MARTíN (1988 a) CALONGE et al. (1989); CALONGE (1990); VIDAL (1991 b); VIDAL (1991 b) as *R. rubescens* L. & Ch. Tul. – Chorology: A, B, Ei, Gi, L, Me, Mll, T.

Rhizopogon subareolatus Smith – ALVAREZ et al. (1993) – Chorology: Gi.

Rhizopogon ventricisporus Smith – ALVAREZ et al. (1993) – Chorology: T.

Rhizopogon vulgaris (Vitt.) M. Lange – CODINA & FONT-QUER (1930) as *Rhizopogon provincialis* Tul.; MAIRE et al. (1933) as *R. provincialis* Tul.; MALENÇON & BERTAULT (1971 b) as *R. provincialis* Tul.; MARTíN (1988 a); VIDAL & PASCUAL (1989); CALONGE (1990); CALONGE et al. (1991 b); VIDAL (1991 b) – Chorology: B, Gi, Mll.

Scleroderma Pers.

Scleroderma areolatum Ehrenb. – CALONGE et al. (1989); CALONGE (1990) – Chorology: Mll.

Scleroderma bovista Fr. – CODINA & FONT QUER (1930); LLISTOSELLA & AGUASCA (1986); JEPPSON (1987); MARTíN (1988 a); CALONGE (1990); VIDAL (1991 a) – Chorology: B, Gi, L.

Scleroderma cepa Pers. – MAIRE et al. (1933) as *Scleroderma verrucosum* Pers. var. *cepa* (Pers.) Maire; CALONGE (1983); LLISTOSELLA & AGUASCA (1986); MARTíN (1988 a); CALONGE et al. (1989); CALONGE (1990); VIDAL (1991 a); VIDAL (1991 a) as *Scleroderma flavidum* Ellis & Everhart[16] – Chorology: B, Gi, Mll.

Scleroderma citrinum Pers. – ROLLAND (1904) as *Scleroderma vulgare* Hornem.; KNOCHE (1921) *S. vulgare* Hornem.; CODINA & FONT QUER (1930) as *S. vulgare* Hornem.; PEARSON (1931) as *S. vulgare* Hornem.; HEIM et al. (1934) as *S. vulgare* Hornem.; MAIRE (1937) as *S. vulgare* Hornem.; SINGER (1947) as *S. aurantium* (L.) Pers.; LLENSA (1968) as *S. vulgare* Vail ex Pers.; LLENSA (1970) as *S. vulgare* Hornem.; POLO (1982) as *S. vulgare* Vail ex Pers.; CALONGE (1983); LLIMONA (1984) as S. vulgare; BARCELÓ (1986); MARTíN (1988 a); CALONGE et al. (1989); CALONGE (1990) – Chorology: B, Gi, L. Mll.

Scleroderma meridionale Demoulin et Malençon – LLISTOSELLA & AGUASCA (1986); MARTíN (1988 a); CALONGE (1990); VIDAL (1991 a) – Chorology: B, Gi.

Scleroderma polyrhizum (J.F.Gmel. : Pers.) Pers. – SOLÀ (1925) as *Sclerangium polyrrhizon* Lév.; CODINA & FONT QUER (1930) as *S. polyrrhizum* (Gmel.) Lév.; MAIRE et al. (1933) as *S. polyrrhiza* (Pers. ex Gmel) Lév.; HEIM et al. (1934) as *S. polyrhizon* (Gmel.) Lév.; MAUBLANC (1936) as *S. polyrrhizum* ; MAIRE (1937) as *Scleroderma polyrhizon* (Pers. ex Gmel.) Lév.; CALONGE & DEMOULIN (1975); BALLESTEROS (1984) as *S. geaster* Fr.; LLIMONA (1984) as *S. geaster*; ROCABRUNA

(1984); BARCELÓ (1986); TABARÉS & ROCABRUNA (1987); MARTÍN (1988 a); LLISTOSELLA & AGUASCA (1990); CALONGE (1990); VIDAL (1991 a) – Chorology: B, Gi.

Scleroderma verrucosum Bull. : Pers. – ARANZADI (1903) as *Scleroderma verrucosum*; ROLLAND (1904) ; ARANZADI (1905); KNOCHE (1921); SOLÀ (1925); CODINA & FONT QUER (1930); CODINA & FONT QUER (1930) as *S. verrucosum* Pers. var. *spadiceum* (Schaeff.) Fr.; MAIRE et al. (1933); HEIM et al. (1934); MAUBLANC (1936); MALENÇON & BERTAULT (1971 a); MALENÇON & BERTAULT (1972); CALONGE (1983); BALLESTEROS (1984); ROCABRUNA (1984); BARCELÓ (1986); AGUASCA & LLISTOSELLA (1987); JEPPSON (1987); TABARÉS & ROCABRUNA (1987); MARTÍN (1988 a); ROCABRUNA & TABARÉS (1988); CALONGE et al. (1989); CALONGE (1990); LLISTOSELLA & AGUASCA (1990); CALONGE et al. (1991 a); CALONGE et al. (1991 b); VIDAL (1991 a); AGUASCA et al. (1992); CALONGE et al. (1992) – Chorology: B, Gi, L, Mll.

Sclerogaster Hesse

Sclerogaster compactus (Tul.) Sacc. – VIDAL (1991 b) – Chorology: Gi.

Sclerogaster gastrosporiodes Pilát & Svrček – VIDAL & PASCUAL (1991); VIDAL (1991 b) – Chorology: Gi.

Sclerogaster hysterangioides (Tul.) Zeller & Dodge – VIDAL (1991 b) – Chorology: Gi.

Sphaerobolus Tode: Pers.

Sphaerobolus stellatus Tode : Pers. – MAIRE et al. (1933); MAIRE (1937); BERTAULT (1982); ROCABRUNA (1984); LLISTOSELLA & AGUASCA (1986); MARTÍN (1988 a); MARTÍN (1988); ROCABRUNA & TABARÉS (1988); TABARÉS & PASCUAL (1988); CALONGE et al (1989) – Chorology: B, Gi, L, Mll, T.

Stephanospora Pat.

Stephanospora caroticolor (Berk.) Pat.[17] – CODINA & FONT QUER (1930) as *Hydnangium carotaecolor* Berk. et Br. – Chorology: T.

Torrendia Bres.

Torrendia pulchella Bres. – VIDAL (1991 a); VIDAL & PASCUAL (1991) – Chorology: Gi.

Tulostoma Pers.

Tulostoma brumale Pers.: Pers. – COLMEIRO (1867)*; BARCELÓ-COMBIS (1879-1881)*; MASFERRER (1887)** as *Tulostoma mammosum* (Mich.) Fr.; ROLLAND (1904) as *T. mammosum* Mich.; KNOCHE (1921) as *T. mammosum* Pers.; BOLÒS (1924) as *T. mammosum* (Mich.) Fr.; CODINA & FONT QUER (1930) as *T. mammosum* (Mich.) Fr.; HEIM et al. (1934); SINGER (1947) as *T. mammosum* (Mich.) Fr.; RIVAS MARTINEZ & LOSA QUINTANA (1969) as *T. mammosum* (Mich.) Fr.; MALENÇON & BERTAULT (1971 a); MALENÇON & BERTAULT (1976); FINSCHOW (1984); LLIMONA (1984); MARTÍN (1987); TABARÉS & ROCABRUNA (1987); WRIGHT (1987); MARTÍN (1988 a); CALONGE & WRIGHT (1989); CALONGE et al. (1989); CALONGE (1990); CALONGE et al. (1991 b); VIDAL (1991 a) – Chorology: B, Ei, Gi, L, Mll.

Tulostoma caespitosum Trabut – MALENÇON & BERTAULT (1972); CALONGE (1990) – Chorology: Me.

Tulostoma cyclophorum Lloyd – MORENO et al. (1990) – Chorology: Gi.

Tulostoma fimbriatum Fr. – CODINA & FONT QUER (1930); MORENO (1.980) as *Tulostoma fimbriatum* var. *campestre* (Morgan) Moreno ; FINSCHOW (1984); MORENO & LADO (1984); BARCELÓ (1986); MARTÍN (1988 a); CALONGE (1990); VIDAL (1991 a) – Chorology: Cs, B, Ei, Gi, T.

Tulostoma fimbriatum Fr. var. **heterosporum** J.E. Wright – MARTÍN (1990 a);

CALONGE (1990); VIDAL (1991 a) – Chorology: Gi, L.

Tulostoma giovanellae Bres. – WRIGHT el al. (1979); MORENO et al. (1984); CALONGE et al. (1989); CALONGE (1990) – Chorology: A, Cs, Mll.

Tulostoma kotlabae Pouzar – MARTÍN (1988 a); VIDAL (1991 a) – Chorology: B, Gi.

Tulostoma lloydii Bres. – MARTÍN (1988 a); CALONGE (1990); CALONGE & MARTÍN (1992) – Chorology: B.

Tulostoma melanocyclum Bres. – CALONGE & MARTÍN (1992) – Chorology: B.

Tulostoma moravecii Pouzar – CALONGE & MARTÍN (1992) – Chorology: B.

Tulostoma squamosum (J.F. Gmel.: Pers.) Pers. – CODINA & FONT QUER (1930); MAIRE (1937); MALENÇON & BERTAULT (1971) as *Tulostoma* cf. *squamosum* Gmel. ex Pers.; FINSCHOW (1984); MARTÍN (1988 a); CALONGE & WRIGHT (1989); CALONGE (1990) – Chorology: B, Ei, Gi, T.

Tulostoma volvulatum Borscow – FINSCHOW (1984) – Chorology: Ei.

Tulostoma xerophilum Long. – CALONGE & MARTÍN (1992) – Chorology: T.

Vascellum Šmarda

Vascellum pratense (Pers.: Pers.) Kreisel – COLMEIRO (1867)*; BARCELÓ-COMBIS (1879–1881)* as *Lycoperdon hyemale* Bull.; COLMEIRO (1889)*; ROLLAND (1904) as *L. pratense* P. and *Calvatia hiemalis* B.; ARANZADI (1905) as *Lycoperdon hiemale* Bull.; KNOCHE (1921) as *L. hiemalis* Bull.; CODINA & FONT QUER (1930) as *L. hiemale* Bull.; HEIM et al. (1934) as *Calvatia hiemalis* (Pers. ex Bull.) Morg.; LLISTOSELLA & AGUASCA (1986); AGUASCA & LLISTOSELLA (1987); MARTÍN (1988 a); ROCABRUNA & TABARÉS (1988); CALONGE et al. (1989); LLISTOSELLA & AGUASCA (1990); CALONGE (1990); CALONGE et al. (1991 a); CALONGE et al. (1991 b); ROCABRUNA & TABARÉS (1991 b) as *Vascellum depressum* (Bonord.) Šmarda; VIDAL (1991 a); CALONGE et al. (1992) – Chorology: B, Gi, L, Mll.

Wakefieldia Corner et Hawker

Wakefieldia macrospora (Hawker) Hawker – VIDAL (1991 b) as *Hymenogaster vaceki*; MARTÍN et. al. (1993) – Chorology: B, Gi.

Remarks

1.– According to CALONGE & DEMOULIN (1975) this species was found at LLOYD's herbarium together with other *Gasteromycetes* under the label: "Leg. T. de Aranzadi (Barcelona), Spain cat. 21999 pp."

2.– Recently, COETZEE & EICKER (1992) have discussed the most appropriate spelling of *Battarraea*. Dr. Demoulin (personal comm.) strongly disagrees. Those authors misinterprete the Code. Rec. 73 B. (1a) is a recommendation nothing more. The only rectifiable feature in *Batarrea* is (under Art. 73.1) to add a second "t". This is so clear that a proposal by Rauschert was introduced to conserve the spelling *Battarraea* which is otherwise unacceptable. This proposal was heavily rejected by the special Committee and this matter is thus closed.

3.– In agreement with CALONGE (1990) the taxonomic position of this species is very doubtful. Some authors consider that *Battarrea phalloides* and *B. stevenii* are synonymous. However, others suggest *B. stevenii* as a larger variety of *B. phalloides*. After studying different samples in the herbarium of Dr. Demoulin (Liège, Belgium), we think that the two species can be easily separated using both their macroscopic features and the hyphal structure of the stipe.

4.– According to Dr. Demoulin for *Bovista dermoxantha* (Vitt.) de Toni there is no problem, because the type of *B. pusilla* (Bastch.) Pers. agrees with *B. limosa* Rostr.

5.– According to Moreno et al., due to the structure of the epicutis, which is hymeniform, the genus *Gastrocybe* Watling is synonymous with *Galeropsis* Velen.

6.– The correct spelling is *Gautieria morchelliformis* Vitt. (Art. 73.2), because of the use of wrong connecting vowels in *G. morchellaeformis* Vitt. is treated as an orthographic error (Rec. 73G).

7.– *Geastrum corollinum* (Bastch) Hollós has priority over *Geastrum recolligens* (Woodw. ex Sow.) Desv.

8.– Geastrum *schimidellii* Vitt. like *Geastrum nanum* Pers. is a superfluous name. In DEMOULIN (1989, p.159) this author discusses the problems of superfluity in fungi. He advises us to use *G. nanum* Pers.

9.– Earliest legitimate name if one assumes that *Geastrum vulgatum* Vitt., which was published in 1842, is synonymous with *G. rufescens* (1801).

10.– According to CALONGE (1990) the type material of this species is apparently lost. Recently, VIDAL (1991 b) has discussed this taxon extensively.

11.– *Hysterangium coriaceum* R. Hesse is the earlier synonymous of *H. separabile* Zeller.

12.– These authours consider *L. atropurpureum* Vitt. and *L. decipiens* Dur. & Mont as synonymous. However, DEMOULIN (1983) affirms that, even though they are very close, these two taxa are independent. Both species can be easily separated using the capillitium, the spore ornamentation and the exoperidium (JEPPSON, 1987).

13.–According to CALONGE (1990) (citing Demoulin, thesis 1971), the only existing collection from Spain is deposited in Lloyd's herbarium, USA. It lacks of any exact locality. The label says: Barcelona, T. de Aranzadi, and lacks an exact locality.

14.– Following DE VRIES (1977) and studying the typification of *M. broomeianus* Berk. ex Tul., Dr. Demoulin considers it as synonymous of *variegatus* (Vitt.) Tul.

15.– The combination *Pisolithus tinctorius* has been made by Desvaux a century before Coker & Couch. However, the correct name is *P. arhizus* (Scop.: Pers.) Rauschert. This was not clear after the Sydney and Berlin Congress, but with the Berlin Code it is clear (Art 14, note 10) that in case of equal sanctioning the oldest name has priority. The only matter that still could be discussed is whether spellings are sactioned. Dr. Demoulin considers to use *arhizus*, but if it would be ruled, perhaps to use *arrizus* could be possible.

16.– Dr. Demoulin does not admit *Scleroderma flavidum* Ellis & Everhart is distinct from *S. cepa* Pers.

17.– See remark 6.

Doubtful taxa mentioned in the literature

Geaster ambiguus Mont.–This taxon was published by CODINA & FONT QUER (1930) and MAIRE (1933) they considered it as synonym of *Geaster striatus* Kalchbr. and *G. striatulus* Kalchbr., respectively.

Geaster queletii Hazsl.– It was published by MAIRE (1933) and could be a *Geastrum quadrifidum* Pers.: Pers.

Hydnangium font-queri Heim et Malençon – According to CALONGE (1990) who studied a small fragment preserved at the herbarium of Montpellier (MPU), France, which could correspond to the type collection. However, with the available data we do not know if this taxon was legitimately published.

Hymenogaster sp.– Published by MAUBLANC (1936) without any additional information.

Hymenogaster sp Nº1. and *Hymenogaster* sp Nº 2.– Recently published by ALVAREZ et al. (1993). They were collected under *Pseudotsuga menziessii.*

Hymenogaster spictensis Pat.– Published under this name by VIDAL (1991 b) and VIDAL & PASCUAL (1991). These authors told us that they have to confirm their identification.

Rhizopogon sp.– It was published by CALONGE & DEMOULIN (1975). By the description given by these authors it could belong to the sect. *ochraceorubescens* A. H. Smith.

Scleroderma aff. *floridanum* Guzmán – Recently, it was published by VIDAL (1991 a).

Scleroderma venosum Boud. – This taxon was published by CODINA & FONT QUER (1930).

Sclerogaster sp.– It was published under this name by VIDAL et al. (1991). According to these authors' description this taxon could be *S. lanatus* Hesse.

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BARRIA, A NEW ASCOMYCETOUS GENUS IN THE PHAEOSPHAERIACEAE

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During a survey of ascomycetous fungi of Xinjiang, China (Central Asia), an unusual fungus, causing needle blight of Schrenk spruce (*Picea schrenkiana* Fisch. et Mey.) was discovered from Tianshan Mountain of Xinjiang. Because this species cannot be accommodated in any of the existing genera, it is described here as the type of the new monotypic genus *Barria*.

The holotype material is deposited in the National Herbarium of Canada in Ottawa (DAOM), and the isotypes in the Herbarium of Mycology, August 1st Agricultural College (HMAAC), Urumqi, Xinjiang, China and in the New York Botanical Garden in Bronx, NY (NY).

Barria Z.Q. Yuan **gen. nov.**

Genus Phaeosphaeriacearum. Ascomata discreta, immersa, sphaerica ad sphaeroidea; ostiolis prominulis; pariete perithecii e cellulis pseudoparenchymatii brunneis composito. Asci octospori, bitunicati, cylindrici vel clavulati. Pseudoparaphyses cellulosae. Ascosporae monostichae, ellipsoideae, brunneae, uniseptatae.

Typus generis: *Barria piceae* Z.Q. Yuan

A genus of Phaeosphaeriaceae with one species. Ascomata separate, immersed, spherical or almost spherical; ostiolate visible on substrate surface; peridium of brown pseudoparenchymatous cells. Asci 8–spored, bitunicate, cylindric to clavulate. Pseudoparaphyses cellular. Ascospores uniseriate, ellipsoid, brown, 1–septate.

Type species: *Barria piceae* Z.Q. Yuan

Barria piceae Z. Q. Yuan **sp. nov.** Fig. 1

Ascomata immersa, globosa, 220–280(–400) µm diametro; peridia 20–35 µm lata, e cellulis pseudoparenchymatii, brunneis, rotundis (c. 8 µm diam) in 3–4 stratis externis et e cellulis compressis tenuitunicatis hyalinis in stratis internis composita. Asci octospori, bitunicati, cylindrici ad clavulati, (75–)134–184 x 14–17 µm. Pseudoparaphyses cellulosae, 2–3 µm crassae, 180–220 µm longae. Ascosporae monostichae, ellipsoideae, primo hyalinae ad viridulae, olivaceae inter maturitatem, 1–septatae in medio vel fere in submedio, insigniter constrictae, (15–)18–24 x (8–)10–13 µm, guttatae; exosporio foveolato, e gelatina cingulato.

In foliis *Piceae schrenkianae* Fisch. et Mey., Monte Tianshanico, Urumqi, Provincia Xinjiangensi, Sinicarum, 1 VII 1992, Z.Q. Yuan 92003, DAOM holotypus. Isotypi in Herb. HMAAC (HMAAC 776) and NY depositi.

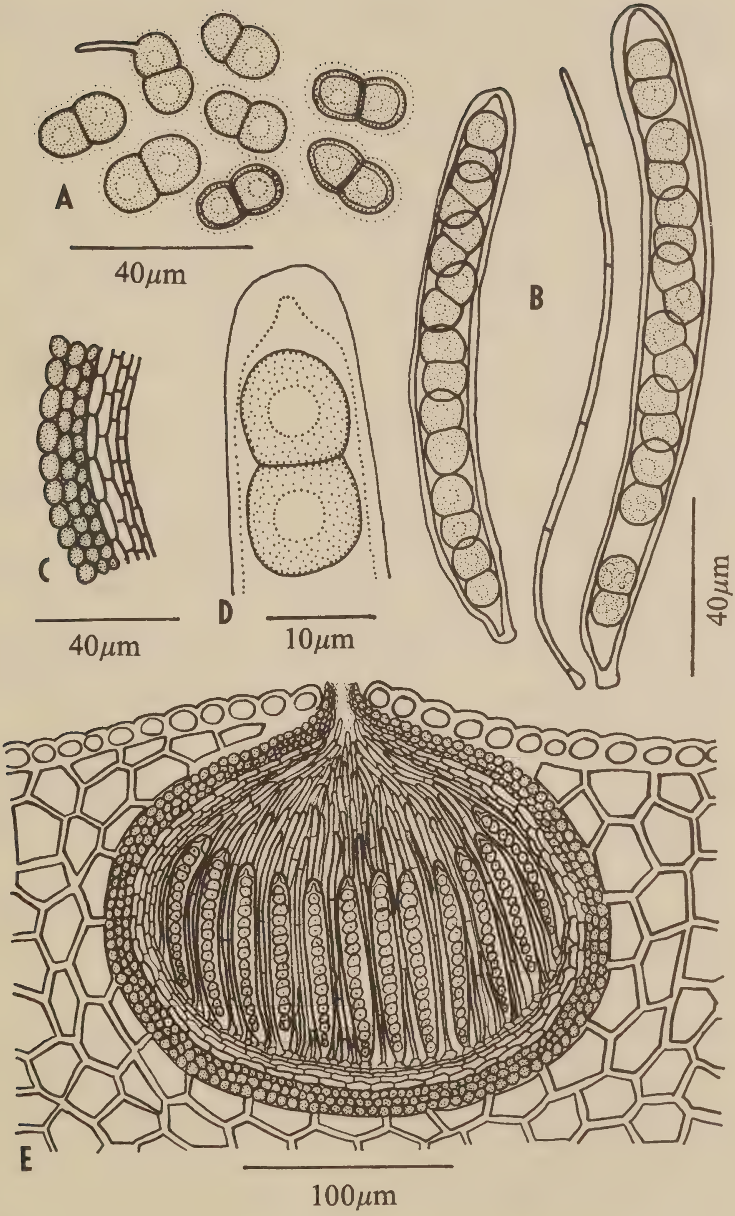
Ascomata immersed, globose or subglobose, 220–280(–400) µm diam. Peridium 20–35 µm wide, with brown round (c. 8 µm diam) pseudoparenchymatous cells in outer 3–4 layers and pallid compressed cells in inner layers. Asci 8–spored, bitunicate, cylindric to clavulate, (75–)134–184 x 14–17 µm. Pseudoparaphyses cellular, 2–3 µm wide, 180–220 µm long. Ascospores uniseriate or some times overlapping in the upper parts, ellipsoid, hyaline or greenish with numerous small guttules at first and olive green to smoky brown at maturity, with septum median or slightly submedian, remarkably constricted at the septum, upper cell 7.5–10.0 µm wide and lower cell 5.0–10.0 µm wide, with one large guttule in each cell, (15–)18–24 x (8–)10–13 µm; wall foveolate, surrounded by gel coating. Few spores germinate to produce a simple tube while in ascomata.

On needles of *Picea schrenkiana* Fisch. et Mey., Tianshan Mountain, Urumqi, Xinjiang, China, 1 VII 1992, Z.Q. Yuan 92003, DAOM holotype, HMAAC 776 and NY isotypes.

DISCUSSION

The literature sources on the loculoascomycetous genera

Fig.1. *Barria piceae*: A. ascospores, B. asci and pseudoparaphysis, C. detail of peridium, D. ascus apex with ascospore, E. ascoma in vertical section.


A
40μm
B
40μm
C
40μm
D
10μm
E
100μm

with dark two–celled ascospores have been searched. There are several genera, such as *Didymosphaeria* Fckl., *Didymopleella* Munk and *Stegasphaeria* Syd. with similarities in ascoma structure, asci or / and ascospores to this new fungus. But to none of them can it be assigned well. It differs from *Didymosphaeria* in the peridium and hamathecium. The peridium in *Didymopleella* is textura prismatica and cells of ascospores strongly unequal (Munk, 1957). Species of *Stegasphaeria*, Meseriaceae have fleshy, light ascomata and are tropical parasites in dicot leaves (Arx and Müller, 1975). The fungal peridium of pseudoparenchymatous and hamathecium of narrowly cellular, not trabeculae pseudoparaphyses in this fungus suggest that it should be placed in the Phaeosphaeriaceae, Pleosporales (sensu Barr, 1979), in its own genus.

Most species in the Phaeosphaeriaceae have multiseptate ascospores. The only genera with one–septate spores are *Didymella* Sacc., *Lautitia* Schatz and *Metameris* Theiss. & Syd., but they are even more different from the new species in ascomata and colour as well as shape of ascospores.

Diseased leave tissue and single ascospore isolations were made on potato dextrose agar (PDA). Growth rate of colonies at 20 ℃ on PDA approximately 3 mm per day, colonies velvety, dark brown. It failed to sporulate no matter exposure to light or darkness. When isolated from diseased leave tissue, *Cladosporium* conidia were frequently associated with the colonies, but were probably air contaminants.

In natural condition, it was observed that the fungus causes blight of infected spruce needles. The preliminary pathogenicity test carried out in the laboratory shows that it is pathogenic.

ACKNOWLEDGMENT

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TWO NEW CORTICIOID FUNGI (APHYLLOPHORALES) FROM NE ARGENTINA AND PARAGUAY.

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ABSTRACT. Two new species of corticioid fungi, namely *Peniophora taraguiensis* (*Peniophoraceae*) and *Xylobolus gongylodes* (*Stereaceae*) are herein described and illustrated. Culture characters of the former are described.

KEY WORDS: *Aphyllophorales*, corticioid fungi, NE Argentina, Paraguay, *Peniophora*, *Xylobolus*.

INTRODUCTION

The corticioid fungi of NE Argentina and Paraguay, are poorly known. The main contributions includes Hjortstam & Ryvarden (1982) with additional information in Gómez & Loewenbaun (1976), Job (1985), Rajchenberg & Wrigth (1987). During a current survey of the poroid and corticioid fungi of the above cited region a large number of specimens is found. Among the collections studied some appear to be undescribed. Two of these are herein described and illustrated.

MATERIALS AND METHODS

Free-hand sections made under a binocular microscope were mounted both in Melzer's reagent (Singer, 1949), and a drop of 5% KOH mixed with a drop of saturated aqueous phloxine. A sulphobenzaldehyde solution (Boidin, 1951) was used to determine the reaction [SA(+) or SA(-)] of gloeocystidia, testing this on fresh material. All measurements were made under oil-immersion, magnified 1000 X. Colors are according to Maerz & Paul (1930), and Munsell (1954). Cultural studies follow the methods proposed by Nobles (1965); terminology and codes, according to Nakasone (1990). Herbaria abreviations are according to Holmgren & al.(1990).

Peniophora taraguiensis Popoff & Wright n.sp.

Basidiocarpo effuso vel effuso-reflexo, adnato, membranaceo, 0.1-0.2 mm crass., primo in discis irregularibus, dein confluentibus; hymenio laevi, in sicco rimoso, roseo-aurantiaco, margo adhaerens, acutiusculo indifferentiato. Systema hypharum monomiticum, hyphis fibulatis 3-5 μm crass., tenuitunicatis vel leviter crassitunicatis. Subiculo tenui, hyphis parietibus brunneis, leviter incrassatis; subhymenio hyphis parietibus hyalinis in "textura intricata" compacta dispositis. Gloeocystidiis cylindricis, apice obtuso, tenuitunicatis vel leviter crassitunicatis, 60-90 x 7-10 μm, sulpho (-), frequens biradicatus. Cystidiis metuloideis, numerosis, in subiculo innatis, primo laevis, dein fortiter incrustatis, in aetate immersis, conicis vel ellipsoideis, 40-60 x 15-25 μm. Basidiis subclavatis, 30-45 x 5-6 μm, 4-sterigmatis, fibulatis. Sporis allantoideis, 7.5-10 x 3-4 μm, tenuitunicatis, laevis, hyalinis, inamyloideis, acyanophilis.

HOLOTYPUS: Argentina, Prov.Corrientes, Depto.Capital, ad corticem *Mangifera indica*, leg. Popoff 1105, 20/IX/91, in Herb. BAFC conservatus est.

Basidiocarp effused to effused-reflexed, adnate, membranous, 0.1-0.2 mm thick, appearing at first as small irregular patches, later confluent; hymenial surface smooth, cracking somewhat upon drying, pinkish-orange ("Light Orange", 11A7, 9B7) when fresh, pinkish ("Light Yellowish Pink" 10B5, 9C5) when dry, margin mostly adhering, thinning, undifferentiated, sometimes with a narrow brown-translucid pellicle.

Hyphal system monomitic; hyphae clamped thin- to slightly thick-walled, 3-5 μm diam.; subiculum thin, formed by brown, slightly thick-walled hyphae arranged in a very compact "textura intricata"; subhymenium formed by hyaline hyphae in a compact "textura intricata". Gloeocystidia cylindric, apex obtuse, thin to slightly thick-walled, 60-90 x 7-10 μm, frequently birradicate, sulpho-negative. Cystidia metuloid, numerous, strongly encrusted, conical to ellipsoid, 40-60 x 15-25 μm, the older ones completely immersed. Basidia subclavate, 30-45 x 5-6 μm, 4-spored, with basal clamp. Spores allantoid, 7.5-10 x 3-4 μm, the walls thin, smooth, hyaline, inamyloid, acyanophilous. Spore print "pink" (5YR8/3-8/4).

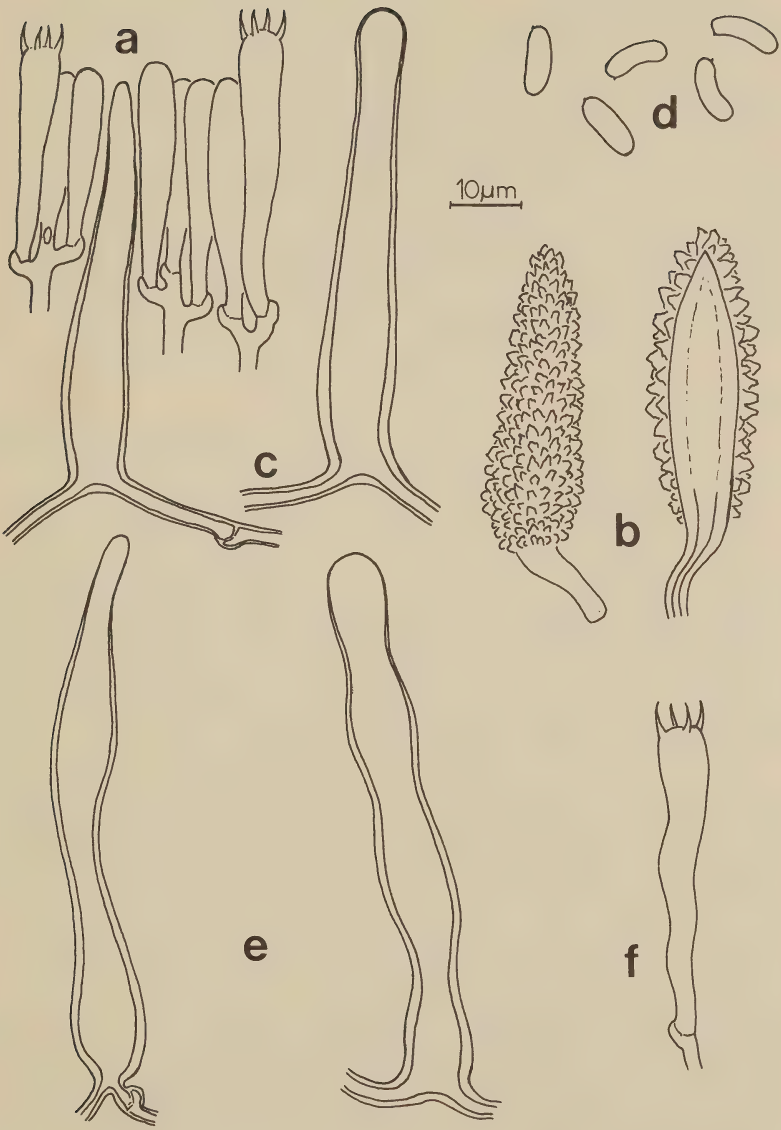

Fig.1. *Peniophora taraguiensis* n.sp., a: sketch of the hymenial layer; b: encrusted old cystidia; c: gloeocystidia; d: spores, (Holotype); e: gloeocystidia and f: basidium both from culture BAFC 762, after 6 weeks.

ETYM.: the specific epithet refers to the region under study (a word from the "guaraní" aborigin language).

MATERIAL STUDIED: The holotype. Ipse, ibid. 1102, 20/01/1992, (CTES). Ipse, ibid. 1201, 13/VII/1992, (CTES). Ipse, ibid. 1313, 14/I/1993, (CTES).

REMARKS: This species belongs to subgenus *Peniophora.* It is very close to *P.crassitunicata* Boidin, Lanquetin & Gilles (1991), from which *P.taraguiensis* differs in having sulpho-negative gloeocystidia, with thinner walls, larger basidia and wider spores. *P.nuda* (Fr.) Bres. and *P.pseudonuda* Hallenb. are also close, but may be separated both macro- and microscopically by the colour of the basidiocarp and by both having sulpho-positive gloeocystidia and smaller metuloid cystidia.

CULTURAL STUDY:

STRAINS: BAFC 762 and 756, both from the type locality and host, leg. O.Popoff 1105 and 1201, respectively.

GROWT: Rapid at 29°C, dishes covered in 2 weeks.

MACROSCOPICS FEATURES: Margin regular. Mat loosely felty, whitish, becoming slightly ochraceous-brown; in the central zone white, cottony, small balls were observed, at first isolated, later coalescent. After the 2nd week small, brownish drops were excreted here and there. Reverse: becoming light brown from the inoculum zone. Odour: of rotten wood that becomes more pronounced at the 4th week, and then sweetish.

MICROSCOPICS FEATURES: Aerial mycelium: hyphae of advancing zone clamped, thin-walled, hyaline, 2-4-(5) μm diam., much branched, generally with short lateral branches, some inflated from time to time; many void of contents. At the 2nd week inflations are more common, and some form strangulated vesicles; in the middle zone, some hyphae become brown and form glomerules, with a tendency to form a pseudoparenchyma, and begin excreting brownish drops. During the last weeks the changes were an increase in the number of ampulliform hyphae, of secretions and of hyphae which lack cytoplasm. Submerged mycelium: much branched, clamped, thin-walled, hyaline hyphae predominate, some torulose, 1.5-6 μm diam., becoming sparser towards the margin; towards the inoculum many are void of contents. At the 2nd week brown glomerules start forming; in the wider hyphae clamps are observed at almost every septum, branches become numerous and are stained light brown. At the 4th week the mycelium is appressed with patches of brown pseudoparenchyma that excrete a brown liquid; empty hyphae are numerous.

Some dishes (BAFC 762) exposed to daylight and at lab temperature may erratically form at the 6th week a fruitbody primordium with cylindric, strangulated cystidia, 58-80 x 9-10 μm, and long, 4-spored basidia, 36-55 x 5.5-7.5 μm with a few allantoid spores, 8.5 x 3.5 μm.

OXIDASE REACTION:	Tannic acid: +++++, growth 25-30 mm.
	Gallic acid: +++++, growth 25 mm.

CODE: 2. 3c. 11. 22. 26. 32. 36. 37. (39). 42. (48). 53. 54. 60.

SEXUALITY: Heterothallic, tetrapolar.

Xylobolus gongylodes Popoff & Wright n.sp.

Basidiocarpo resupinato vel irregulariter pulvinato, plus minusve lignoso, 3-4 mm crass., interdum crassior, conspicue pluristratoso, plerumque in sicco profunde rimoso, in iuventute verruciformibus, orbiculare, dein confluentibus, irregulariter dimidiato ad marginem truncum, parte superioribus glabra, leviter zonate, obscure brunneis; hymenio laevi vel leviter tuberculato, humido cremeo-cinereo vel cinereo-cyaneo, cremeo vel cinereo in sicco.

Systema hypharum dimiticis, hyphis generativis afibulatis, verticalibus dispositis, cellulis curtis ad transitoris acanthocystidiis, 2.5-5 μm crass., hyalinis, stratis vetustibus flavo-brunneis vel obscure brunneis; hyphis skeleticis sparcis, vix observantus, tenui- vel moderate crassitunicatis, 3.5-5.5 μm cras., verticalibus dispositis; subhymenio a "textura intricata-porrecta", in sectionibus tenuibus pseudoparenchymatis, sed manifeste verticalibus dispositis. Pseudocystidiis (skeletocystidiis) rarior, cylindricis, flexuosis, tenui- vel leviter crassitunicatis, 30-66 x 4.5-7 μm, nunquam procurrentibus in hymenio, reactione sulphovanillina cinerea. Acanthocystidiis (hyphis acantophysoideis) numerosis, maxime variat structura et forma, tenuitunicatis, hyalinis, (15)-17.5-20-(23) x 4-6-(7) μm. Basidiis (acanthobasidiis) subclavatis, 23-30 x 5-6.5 μm, ad medium leviter constipatus, 4-sterigmatis. Sporis ellipsoideis vel ovoideis, ad axem rectis, 5.3-7.3 x 3.5-4.8 μm, interdum in tetradibus, tenui- vel leviter crassitunicatis, laevis, amyloideis.

HOLOTYPUS: Paraguay, Dpto. Amambay, Parque Nac. Cerro Corá, Cerro Muralla, leg. Ferraro & al. 3357, IX/88, in herb. BAFC conservatus est.

Fruitbody resupinate to irregularly pulvinate, more or less woody, 3-4 mm thick, sometimes thicker, distinctly stratified in several layers, usually deeply cracked when dry, in the beginning wart-like, orbicular, finally confluent, irregularly dimidiate at the margin and then with the upper part glabrous, slightly zonate, dark brown; hymenial surface smooth to slightly tuberculate, greyish-cream to greyish-blue when wet, cream to grayish white (10YR 6/3 to 10YR 4/3) in herb.

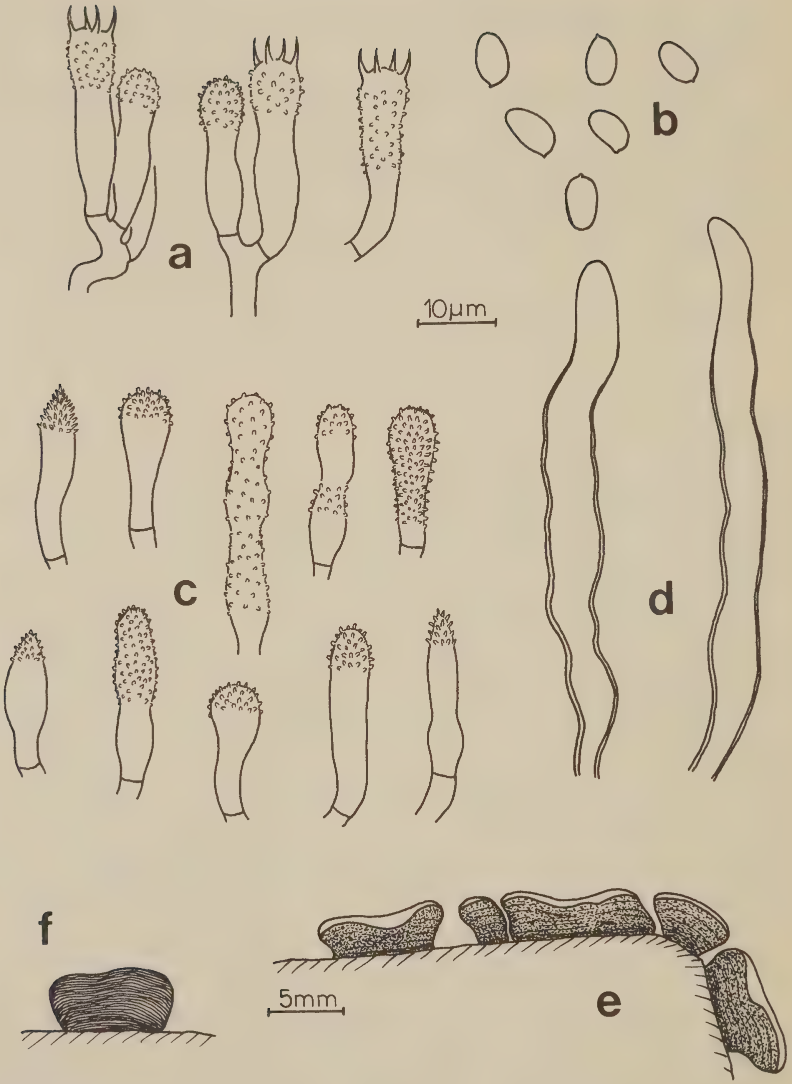

Fig.2. *Xylobolus gongylodes* n.sp., a: basidia , b: spores, c: types of acanthocystidia, (Popoff 626); d: pseudocystidia, e: general view of fruitbodies, f: cross-section showing distinct layers of the fruitbody, (holotypus).

Hyphal system dimitic, generative hyphae simple septate, vertically arranged, short-celled and with transitions to acanthocystidia, 2.5-5 µm wide, hyaline, brownish yellow in old layers and more strongly pigmented in the older ones, skeletal hyphae few, difficult to observe, thin to moderately thick-walled, 3.5-5.5 µm wide, vertically arranged; subhymenium a textura "intricata-porrecta", pseudoparenchymatic-like in thin sections, but clearly vertically arranged. Pseudocystidia (skeletocystidia) rare, cylindric flexuos, thin- to slightly thick-walled, 30-66 x 4.5-7 µm, never projecting above the basidia and acanthocystidia, turning grayish in sulphovanillin. Acanthocystidia (acanthophysoid hyphae) very numerous, varying in form, (15)17.5-20(23) x 4-6(7) µm, thin walled, hyaline. Basidia (acanthobasidia) subclavate, 23-30 x 5-6.5 µm, slightly constricted in the middle part, 4-sterigmata. Spores ellipsoid to ovoid, adaxially straight, 5.3-7.3 x 3.5-4.8 µm, sometimes united in groups of four, thin to slightly thick-walled, smooth, amyloid.

ETYM.: the specific epithet refers to the somewhat knob-shaped fruitbodies.

MATERIAL STUDIED: The holotype. Argentina, Corrientes, Dpto. Itatí, Yacareí, in the forest, leg.: O.Popoff 626, 04/II/90, (CTES). Ipse, Dpto. Ituzaingó, Isla Apipé Grande, in the forest, leg.: Popoff & al. 601, 26/XI/88, (CTES). Paraguay, Dpto.Itapúa, Isla Yacyretá, in the forest, leg.: Popoff & al. 569, 25/XI/88, (CTES).

REMARKS: *X.frustulatus* Boidin (1959) is very similar, but *X.gongylodes* may be separated by its slightly larger spores and variable forms of acanthocystidia. Species of *Xylobolus* have generally short spores (up to 6 µm long), and growing on *Quercus spp. X.gongylodes* is always found on fallen decorticated hard-hoods, but *Quercus* is not found in natural forests of South America.

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THE FLORISTIC AND LICHENOLOGICAL WORK OF ROY LATHAM ON EASTERN LONG ISLAND, NEW YORK

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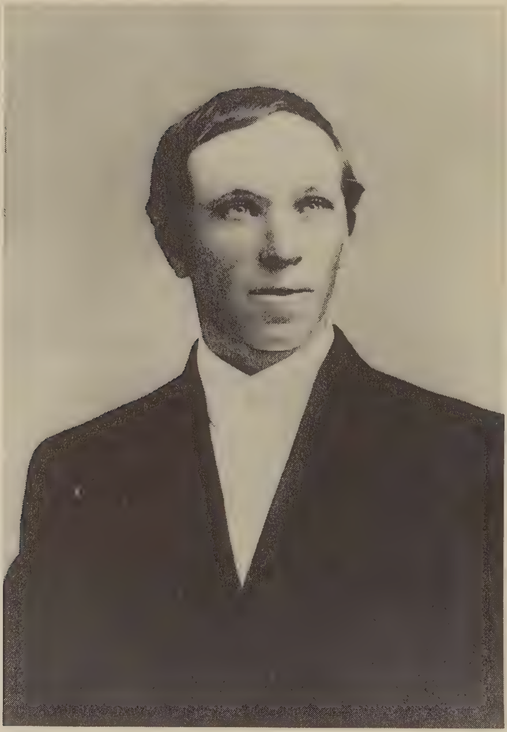
ABSTRACT: ROY LATHAM (1881-1979, portrait and brief biography included), a native of Orient, Long Island, New York, was one of the most important field naturalists of northeastern North America. A potato farmer and commercial fisherman by occupation, Latham was deeply interested in all natural history disciplines, including archaeology. He collected and deposited in museums ca. 245,000 specimens, and published extensively in scientific journals (300+ papers). After becoming interested in lichens at age 25, Latham collected and observed them during the rest of his life. His lichen collection of ca. 2000 specimens provided an invaluable historical baseline for Irwin M. Brodo's 1968 work *The Lichens of Long Island, New York: A Vegetational and Floristic Analysis*. Latham's lichen vouchers were deposited in NYS in 1969, with some duplicates given to CUP decades before via STEWART H. BURNHAM (1870-1943, portrait and brief biography included), with whom Latham collaborated on a flora of the Town of Southold and Gardiner's Island, Suffolk County, New York. Some Latham specimens were also sent to specialists for determination, and remain at their institutions. Historical details on Latham's natural history specimens, his friendship with Burnham, and his perceptions of *Cetraria arenaria, Cladina stellaris, Cladina rangiferina*, and *Platismatia tuckermanii* (all of special interest on Long Island) are provided from Latham letters and literature. **KEY WORDS:** Roy Latham, lichens, Long Island (New York), Stewart H. Burnham, New York State, naturalists, *Cetraria, Cladina, Platismatia*, Atlantic Coastal Plain.



Roy Latham

Figure 1. Roy Latham of Orient, Long Island, New York, in 1912, from a portrait originally belonging to Stewart H. Burnham; signature from 25 April 1910 (Cornell University Archives).

The Orient Naturalist

ROY LATHAM (Fig. 1), New York State's most versatile field naturalist, was born at Orient, Suffolk County, on 23 May 1881, a descendant of Jonathan Fish Latham who settled there in the 1790's (D. Latham 1993). Roy's parents were Fred and Fanny Latham. Christened Angelo Roy Latham, the "little angel" soon dropped the Angelo, perhaps retaining it as a rarely used middle name [his Southold and Gardiner's Island flora (Burnham & Latham 1914-1925) was signed "Roy A. Latham"; see also Chaudhri *et al.* 1972]. He attended the one-room school in Orient for two or three months each winter over several years, but was largely self-educated, avidly pursuing studies that interested him for the rest of his life. Roy and his father and brothers were active commercial fishermen early in this century, their business peaking between 1915 and 1920; but his main money-making occupation was growing potatoes at his farm ("The Osprey's Nest" on Private Road in Orient), which he pursued until 1964. After retiring he leased his land to other Orient farmers, while continuing his intense, lifelong labor of love: studying the natural history of eastern Long Island.

Roy's fascination with the natural world began at age three, and continued throughout his life. It spanned the gamut of natural history disciplines, including ornithology, mammology, herpetology, ichthyology, entomology, botany, lichenology, mycology, bryology, phycology, and archaeology. A highly organized person who kept labelled specimens of everything he found, he amassed huge collections of inestimable scientific value in all areas of interest. The worth of Roy's collections is enhanced by their temporal span and regional focus. The scope of his knowledge and experience was evident in whatever he wrote. It was difficult for him to communicate about any organism without mentioning others that were ecologically or locally associated, often in great detail. Roy's innate brilliance and self-direction, in combination with his extraordinary memory and long life, fostered his eminence among amateur North American naturalists. Although a private person, he confidently approached the greatest authorities on subjects that interested him, gaining their respect and cooperation by the intelligence of his questions and through the specimens and first-hand knowledge he offered. He was repeatedly credited as a major source in references dealing with the natural history of Long Island (among them Bull 1964:15; Brodo 1968; Leonard 1971, 1975; Connor 1978; Lamont & Stalter 1991; and Biechele 1993b).

It was always exciting to receive a letter from Roy Latham. These were written with an ancient typewriter (an Oliver No. 7, purchased in 1912–Latham letter to me, 4 October 1977) on stationery featuring an Osprey's nest atop an abandoned windmill on his farm. He provided exceptionally clear and detailed summaries of his natural history experiences in response to specific queries, interpreted in an environmental and historical context that spanned nearly a whole century. When other naturalists wrote to him with questions, Roy would modestly declare he was too old, or his eyesight was too poor, to look up his records or write much of an answer, and then would deliver an astounding wealth of information. His comments were often tinged with wistfulness, as if recollections of the former abundance of plants and animals were painful. This is understandable–he had watched the flora and especially the fauna disappear in his lifetime, in response to increasing human pressures. Few people could muster such information so easily or present it so beautifully and generously. [Roy's letters to me, quoted (with very slight editing) throughout this article, will be deposited in the Cornell University Archives.]

During the last few years of his life, despite failing eyesight, Latham continued to collect natural history specimens on his farm, remaining active through age 98. Roy died at his home on 13 November 1979, and was buried in the Orient Central Cemetery. At the time of his passing, he was survived by his wife Lulah Mae Vail Latham (whom he married in 1936); a sister, Ruby Peterson; three daughters, Rosemary Barreda, Lydia David, and Diana Latham; and four grandchildren (Zawyrucha 1977, Anon. 1979). Table 1 provides a summary of important events in Roy's life, emphasizing his floristic and lichenological accomplishments.

Roy Latham possessed an innate genius for documenting what he saw, and had the responsibility and good sense to deposit his specimens in museums and to communicate about them in arenas accessible to other naturalists. He published extensively in scientific journals over a seventy-year span. Frederick C. Schlauch, the foremost authority on his publications, estimated that there may be over 300 papers scattered through the literature of the diverse disciplines that interested him (Schlauch, verbal comm.). Between 1968 and 1978, more than a hundred papers and notes by Latham were published in *Engelhardtia* and *The Pitch Pine Naturalist*, journals of the Northeastern Field Naturalists' Society [formerly Long Island Herpetological Society]. Schlauch had founded this group in 1965, and edited its publications. A voluminous correspondence from 1967 to 1979 between Schlauch and Latham strongly bonded these two naturalists, resulting in this unsurpassed contribution to the Long Island natural history literature.

The Floristic Work of Roy Latham

Because his knowledge was so comprehensive, I cannot discuss Latham's lichenological work without making frequent references to related areas of natural history, especially botany. The preceding notes on his life, compiled from Schlauch (1971), Zawyrucha (1977), Anon. (1979), Pechuman (1979), D. Latham (1993), F. C. Schlauch (verbal comm.), and C. J. Sheviak (verbal comm.), have indicated the context in which his lichenological work was done.

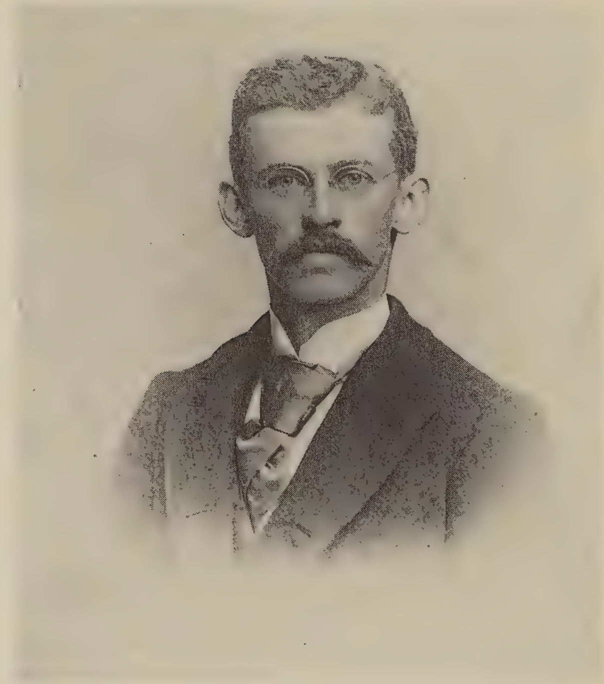
Although Roy Latham witnessed the development of the automobile as a familiar mode of transportation, he travelled extensively by boat, horse and wagon, bicycle, and on foot (Schlauch 1971). He mentioned crawling on hands and knees over every inch of certain tracts (letter to me, 4 October 1977), which he must have done to obtain the records his specimens prove. This slow pace allowed close observation, and is undoubtedly responsible for his outstanding success in locating natural history treasures throughout eastern Long Island.

Among Latham's botanical writings, "The Flora of the Town of Southold, Long Island and Gardiner's Island," co-authored with Stewart H. Burnham, with its five supplementary lists (Burnham & Latham 1914-1925), was his monumental achievement, representing many years of field work and study of collected specimens. Observations for this flora began before 1900 (Latham 1957).

It is fortunate that Roy became acquainted with STEWART HENRY BURNHAM (Fig. 2), himself an extraordinarily thorough natural history collector and record-keeper interested in vascular plants, cryptogams, and ornithology. Burnham was born at Vaughns (near Hudson Falls) in Washington County, New York, on 6 October 1870. After studying in local schools, he attended Stanford University from 1893-1895; then finished his undergraduate degree at the University of Michigan at Ann Arbor, graduating with a B.S. on 22 June 1899. Further studies were undertaken at Cornell University in 1904-1905. His concentration was botany. Burnham's professional credits are impressive: Museum Aid at the New York Botanical Garden (1901-1903), Assistant in Botany at Cornell (1904-1905), Assistant State Botanist of New York with Charles H. Peck (1905-1913), Assistant in Botany at Cornell (1920-1922), and Assistant Curator of the Cornell University Herbarium (1922 until ca. 1940). Burnham died at Hudson Falls, New York, on 25 September 1943 (Cattell & Cattell 1927; Barnhart 1965).

In the introduction to their flora (Burnham & Latham 1914-1925), Burnham wrote: "Roy A. Latham of Orient, from May 25, 1909, until the present time [probably 1913], collected the following plants: and many of the specimens passed through my hands while in the State Botanist's office at Albany, New York.... [T]he... specimens are preserved in the New York State Herbarium...." This well illustrates Latham's method of communicating with appropriate professionals to their mutual benefit, and indicates that he began serious floristic work in his late twenties. A large cache of mycological correspondence from Latham to Burnham from 1901 and 1909-1913 is preserved at the New York State Museum Herbarium (NYS), with the records of Charles H. Peck (John H. Haines & Lorinda Leonardi, verbal comm.; copies in Cornell University Archives). Unfortunately and surprisingly, no letters to or from Roy are in Burnham's correspondence at the Cornell University Archives, where the extremely meticulous journals and many other artifacts of this important Victorian botanist are also housed.

The flora these two men produced is outstanding in its scope, covering insect galls, algae, fungi, lichens, bryophytes, and vascular plants. Burnham had the professional connections and scientific society



Stewart Henry Burnham

Figure 2. Stewart Henry Burnham while he was working as Assistant State Botanist with Charles H. Peck at the New York State Museum in Albany, between 1905 and 1913; signature from 27 November 1906 (Cornell University Archives.)

affiliations (Cattell & Cattell 1927) to facilitate identifications by specialists, which enhanced the quality of their catalogue. They updated it five times over the next ten years. It remains a model from the period, and is a baseline of information about this region's entire flora, as well as an important historical document concerning the biota of the Mid-Atlantic Coastal Plain.

Voucher specimens for this flora were deposited (as they were sent for identification) at NYS (also at some specialists' institutions, as indicated); but Burnham kept many significant Latham specimens for his enormous personal herbarium (75,000 specimens, Lanjouw & Stafleu 1954), which now forms an important nucleus of eastern New York material in the Cornell University herbaria (BH-CU, and CUP) (Korf 1991). Roy's personal botanical, lichenological, and mycological herbarium of several thousand specimens was given to NYS in 1969 (Zawyrucha 1977, D. Latham 1993). Although these sources (previous sentence) estimated 100,000 specimens in Latham's herbarium, NYS curators cannot have received that many, since Latham's material would then constitute a third of their holdings, which it does not (C. J. Sheviak, verbal comm.). This high figure may represent a grand total of sheets and packets, including the many duplicates Roy sent to specialists for identification, and not total number of collections.

Roy's "Flora of the State Park, Orient, Long Island, N. Y." (Latham 1934a) is another significant paper, with its notes on vegetation and abundance of individual species. He treated the vascular flora "only," but characteristically could not write about the beach without brief mention of important breeding birds, fungi, lichens, and marine algae. This paper provided the historical foundation for a recent floristic re-survey of the same tract conducted by Lamont & Stalter (1991).

Brodo (1968:201), in discussing the one Long Island specimen and eastern North American distribution of *Cladina terrae-novae* (Ahti) Hale &. Culb., commented that the Curlygrass Fern (*Schizaea pusilla* Pursh) had a parallel distribution, and although unknown on Long Island, might be there. Roy's letter to me of 8 December 1976 contained these notes on this subtle pteridophyte, which has proved to be one of the rarest Long Island plants: "I did find the curly grass in two places on Montauk, one patch south of the highway and the other in the far western end, near the bay." This fern was one of Latham's most important floristic discoveries.

As would be expected of someone making observations in one place over so many years, Roy documented the establishment or spread of several plants on eastern Long Island. These included Purple Loosestrife (*Lythrum salicaria* L.) (Latham 1938); Common Reed [*Phragmites australis* (Cav.) Trin. *ex* Steud.] (Latham 1957); Santa Maria (*Parthenium hysterophorus* L.) (Latham 1972a); Common Purslane (*Portulaca oleracea* L.) (Latham 1978a); Yucca (*Yucca flaccida* Haw), and Pyxie (*Pyxidanthera barbulata* Michx.) (Latham 1978b). Roy also reported Tall Blue Lettuce [*Lactuca biennis* (Moench) Fern.], which came up in debris deposited by the 1938 hurricane, but had not been previously noticed (Latham 1955). Zawyrucha (1977) quoted a Latham letter to him concerning Mexican Husk-Tomato (*Physalis ixocarpa* Brot. *ex* Hornem.) at Orient. These publications well illustrate the historical value of Latham's sustained botanical efforts.

Roy's work with cryptogams is well documented in the Southold and Gardiner's Island flora (Burnham & Latham 1914-1925). Further notes on cryptogams appeared separately. In his "Nature Notes from Orient" (Latham 1954, 1956), Roy mentioned specific mosses used by the Prairie Warbler (*Dendroica discolor*) as nest linings. In other papers he reported moss hosts of the muscicolous fungus *Cyphella muscigena* Fr. (Latham 1920), and described the "Habitat of [the liverwort] *Cephalozia francisci* on Long Island" (Latham 1917). Specific basidiomycetes and galls eaten by the Eastern Box Turtle (*Terrapene carolina carolina*) were listed in herpetological publications (Latham 1916, 1968, 1969a).

Additional botanical papers (Latham 1927, 1930, 1934b, 1940, 1971a, 1971b, 1972c, 1972d) were evaluated by Lamont (1993), Stoutenburgh (1993), Biechele (1993a), and Dirig (1993). Biechele (1993b) assessed and updated Latham's records of eastern Long Island Hepaticae and Anthocerotae. Slack (1987:31) noted that Latham correspondence with Charles H. Peck regarding bryophytes also exists at NYS.

The following examples indicate the necessity of scrutinizing Latham's entire literature (even though the titles may not mention flora) for important botanical tidbits that do not appear elsewhere: The destruction of Buttonbush (*Cephalanthus occidentalis* L.) swamps at Orient is discussed in a paper on turtles (Latham 1969b), while the existence of an Atlantic White Cedar [*Chamaecyparis thyoides* (L.) BSP.] swamp on Plum Island is documented in an article on Ospreys (*Pandion haliaetus*) (Latham 1969c). Roy's report of White Oak (*Quercus alba* L.) on western Long Beach, at Orient Beach State Park, in "The Black-crowned Night Heron at Orient, Long Island" (Latham 1972b), would seem of little significance; but the value of this observation vastly increases when one realizes that the historic or contemporary presence of *Q. alba* was not mentioned by Latham (1934a) or Lamont & Stalter (1991) in their floristic accounts of the Park. Close study of all of Latham's publications would require many months. I have not checked numerous zoological and archaeological papers by Latham, which, because of his attention to detail, will undoubtedly contain incidental but significant references to the flora and perhaps to lichens.

Roy Latham, The Lichenologist

Roy Latham noticed and collected Long Island lichens throughout much of his life: "My observations of lichens started in 1910 and continued with regularity until 1930 and intermittently thereafter"

(Latham 1945). A number of Long Island records are known only from Roy's collections (Brodo 1968: 276-277).

The Southold and Gardiner's Island flora (Burnham & Latham 1914-1925) contained an extensive list of lichens, and included a few new combinations (with Burnham).

Latham continued to collect lichens, later becoming intrigued with "Iceland Moss" ["*Cetraria islandica* (L.) Ach.," now known as *Cetraria arenaria* Kärnef., Parmeliaceae], which he carefully documented on eastern Long Island (Latham 1945, 1946, 1947, 1948). Of this species, he wrote (letter, 8 December 1976): "By early 1950 I considered it so general that it could be seen wherever looked for from Montauk west." Personal field work on Long Island after 1974 has shown *Cetraria arenaria* still to be widespread on the East End, but it has disappeared from the Hempstead Plains (Nassau County) since Brodo's field work in the 1960's.

Another species of special interest was Alpine Reindeer Lichen ["*Cladonia alpestris* (L.) Rabenh.," now called *Cladina stellaris* (Opiz) Brodo, Cladoniaceae], which Roy first mentioned in the Orient State Park flora (Latham 1934a) and treated in detail in later papers (Latham 1947, 1949). Latham (letter, 8 December 1976) remarked that this lichen "seems to be a disappearing species on Long Island. I noticed that thirty years ago. I believe it can still be found in the Montauk-Napeague region. Look under the margins of bushes, rather than in the open spaces." I have seen depauperate *Cladina stellaris* at Napeague in 1984 (*Dirig L-1615* in NY). Harris *et al.* (1987) also found it there in 1986. Recent Long Island material does not approach the luxuriance of specimens collected in similar habitats on Cape Cod, Massachusetts, or in upstate New York pine barrens (Oneida and Clinton Counties).

Brodo (1968) did not consider *Cladina rangiferina* (L.) Nyl. to be at all common on Long Island, and neither do I. Latham collected 25 specimens in earlier years (Brodo 1968: 201), and wrote (letter to me, 8 December 1976): "*Cladonia rangiferina* [a synonym] was much more common than *alpestris*. I never considered it as rare as Brodo did. In my old collecting years, I thought it locally common throughout."

Herbarium searching and personal field work in Long Island bogs disclosed several unreported specimens of a beautiful bluish grey, foliose lichen, *Platismatia tuckermanii* (Oakes) W. Culb. & C. Culb., Parmeliaceae. Noting how rarely this had been previously recorded on Long Island (Brodo 1968: 239-240), I wrote to Roy for his thoughts. His richly detailed answers are revealing. In his letter of 10 April 1977, Roy wrote:

> I congratulate you on finding *Cetraria tuckermanii* [a synonym] near Flanders [at Owl Pond, *Dirig L-279*, in my herbarium].... I thought I had *tuckermanii* from a number of places, Napeague, near Montauk, Sag Harbor, Flanders, Riverhead, and North Sea; Brodo evidently discarded all but the North Sea record. I well recall that habitat because there was a group of the rare little Adder's-tongue fern, *Ophioglossum* [*vulgatum* L.], nearby, my third station on Long Island.... This *tuckermanii* was on the low branches of *Chamaecyparis* in a boggy depression which contained the largest

> [Atlantic] white cedar I had a record of on Long Island.... There are several stands of white cedars in the Flanders area. The collection I had was more than a mile from Owl Pond. There are several good stands of swamp cedars in the Riverhead area and three stands in the North Sea region. All I thought were *tuckermanii* were on low branches of the white cedar, except the one at Napeague, which was on beach plum [*Prunus maritima* Marsh.] shrubs in a wet sandy gully.... I doubt if *tuckermanii* is as rare as Brodo thinks on Long Island.

A later letter (4 October 1977) gave more details:

> Northwest is a big region, and not too far from Northsea [*sic*, probably the same as "North Sea" of the previous letter]. It was a prime region for me between Sag Harbor and the Hamptons. There were ... acres of white pine, *Pinus strobus* [L.], that [were] lumber cut years ago. A few large trees still remain. It is wet ground with many small swamps scattered throughout. The woods border on salt marshes. I found many rare plants, aside from lichens, at Northwest, some new to L. I. The *Cetraria*, as I remember, was on twigs and small branches of various kinds near the ground in the wet woods all through the region.... At Northsea [*sic*] there were white cedar swamps, some large old trees; no white cedars at Northwest, just white pines and mixed other growth. I ... crawled over the region ... on my hands and knees. I have not been there in years, and some of Northwest may now be summer homes. When I was there in the 1940's and before, there was not a sign of human life all day at Northwest.

Harris *et al.* (1987) later reported an additional record of *Platismatia tuckermanii* from Long Island (*Buck 13926* in NY).

Of his specimens Roy wrote (letter, 8 December 1976): "My lichens, as named by Brodo, are in the New York State Museum in Albany.... The number is around 2,000...." He continued (letter, 12 September 1977):

> All the lichens I sent to Cornell were through Burnham. As I remember now, Stewart Burnham was a close friend before 1910, when he was in botany with Dr. Peck at Albany.... I sent him thousands of plants, including many lichens, for the State collection, as they had very little from eastern Long Island. Later, when he moved to Ithaca [after 1920], I sent him a few specimens. I do know that he retained part of the lichen material that I sent to him at his home for his own collection. He may have given most of that to Cornell.... Burnham and I had a steady correspondence for many years about birds, plants, botany in general, and home life. I sent him, among other [things], ... marine algae, [with] which he was delighted ..., as he said it gave him "a whiff of the sea."

I have seen some of Roy's original packets, with labels or information typed with the same typewriter as his letters. His collection title was "Flora of Long Island." Roy "did not use Suffolk County much, if any" as a title (letter, 12 September 1977). Most of Roy's cryptogam specimens have been repacketed by herbarium curators, and in many cases, new labels prepared. The original packet was unusual. Many cryptogam collectors fold a rectangular piece of paper in thirds, like a business letter, then fold the ends under. Roy folded the paper in thirds, longways, with the top and bottom folded under, producing a roomier enclosure for specimens. Further details on his lichen collection were given to me in letters dated 12 September 1977 and 4 October 1977.

Roy's lichen collection provided an invaluable historical baseline for Irwin M. Brodo's (1968) work *The Lichens of Long Island, New York: A Vegetational and Floristic Analysis*. Latham found nearly fifty species that Brodo and others have not seen again on Long Island (Brodo 1968:276). Claire K. Schmitt (letter, 2 December 1993) noted that Latham's "collections form the backbone of the lichen herbarium at the New York State Museum." Harris *et al.* (1987) published an updated list of Long Island lichens, adding five new species. Harris (1987) summarized additional Long Island lichen records. Imshaug & Brodo (1966:24) even named a lichen subspecies for Roy: *Lecanora caesiorubella* Ach., ssp. *lathamii* Imsh. & Brodo.

In addition to collecting specimens, Roy's knowledge of lichen natural history was unique. Who but Roy Latham would have observed the lichen species used for nest ornamentation by the Ruby-throated Hummingbird (*Archilochus colubris*) (Latham 1954)? Or recorded the Parula Warbler (*Parula americana*) nesting in festoons of *Usnea trichodea* Ach. (letter to Burnham, 27 Dec. 1909, NYS)? Or documented the disappearance of specific lichens at Orient Beach State Park, after the great hurricanes of 1938 and 1944 (Latham 1945, Brodo 1968:276)? Natural history and life history observations of lichens are rare in the literature because lichenology is still a developing field, when compared to ornithology, for example. Relatively few North American naturalists know the names of lichens, yet anything about their natural history. But this modest Long Island farmer did know a great deal about them.

The Latham Legacy

A number of circumstances and personal characteristics combined to produce this natural history genius. Roy lived for nearly a century on a beautiful island filled with many biological treasures. Self-employment in outdoor occupations provided frequent opportunities to observe and collect natural history specimens, or to take the time to investigate something that interested him. The isolation of his environment, combined with his intelligence, curiosity, attention to detail, love and respect for other organisms, and observational skills, led to natural history study as an entertaining pastime. An intense focus and self-direction, unusual record-keeping instincts, and a vacant building on his farm resulted in large collections in all groups. His knack for acquiring proper references and studying anything he wanted to learn allowed him to identify collected material, or find authorities to whom he could apply for assistance. And an inborn talent for remarkably clear, direct writing enabled him to publish his findings. Roy was a brilliant person who might have been a college professor or museum curator, but he chose the simplicity and beauty of a rural existence, and his life story teaches valuable lessons in disciplined work, happiness, and longevity.

The biological and archaeological specimens Roy Latham collected throughout his life have been deposited as follows (Bull 1964, Schlauch 1971, Zawyrucha 1977, Connor 1978, Anon. 1979, Pechuman 1979, Dirig 1993, D. Latham 1993): "100,000" [actually fewer; see notes above] botanical and mycological specimens (vascular plants, bryophytes, fungi, lichens, and algae) and 10,000 zoological specimens (birds, mammals, amphibians, reptiles, fishes, and mollusks) were given to the New York State Museum at Albany in 1969. An estimated 100,000 insects were donated to the Cornell University Insect Collection in 1968; and hundreds of botanical, lichenological, and mycological vouchers were deposited in the Cornell herbaria via Burnham, as well. Roy's 30,000 aboriginal artifacts, including specimens from the "Orient Phase" culture of ca. 1300-1000 B.C., which he discovered (Pechuman 1979), now belong to the Long Island Chapter of the New York State Archaeological Association, at the Southold Museum, Main Bayview Avenue, Southold. What an eloquent and enduring testimony to an industrious life!

One of Roy's most significant accomplishments was his careful documentation of the effects of the great hurricanes of 1938 and 1944 on the biota of eastern Long Island. This is evident in later publications (Latham 1945, 1955, and many of his papers in *Engelhardtia*); and his letters on the topic have been extensively quoted (Bull 1964, Brodo 1968, Schlauch 1971, Zawyrucha 1977).

Roy Latham was among the great general field naturalists of the Northeast, ranking with James Eights of Albany, New York (Miller 1980, Miller & Goldsmith 1980), William T. Davis of Staten Island, New York (Abbott 1949), and Daniel Smiley Jr. of Mohonk Lake, New York (Winerip 1986, Huyghe 1991), yet holding a unique position, similar to that of Gilbert White in England (Massingham 1983), from having thoroughly studied and recorded his region over an entire century.

Gifted naturalists of this calibre are rare, and appear to be born that way. All have an instinctive grasp of a primary field principle: Knowledge of natural history comes from time spent outdoors, but many encounters, especially with animals, occur by coincidence; thus knowledge is only slowly acquired, and it becomes intensely interesting, and often challenging, to collect and organize experiences to produce ever-increasing degrees of refinement and understanding. Few philosophies of life could be more absorbing than to be always watchful for an organism you never before have seen—flying before you, swimming around the bend in the stream, hidden under the next leaf, or growing between the grains of sand at your feet. How fortunate we are that Roy Latham followed this code so thoroughly and so well!

◆

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Table 1: Summary of Important Events in Roy Latham's Life, Highlighting His Floristic and Lichenological Achievements

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1881, 23 May: Born at Orient, Long Island, New York.
1884: Interest in natural history sparked at age three.
1890's: Observations and collections for Town of Southold and Gardiner's Island flora began.
1909-1913: Sent botanical and mycological specimens for identification and deposit in the NYS herbarium to Stewart H. Burnham, Assistant State Botanist.
1910: First observations and specimens of lichens (continuing regularly until 1930, and intermittently thereafter).
1912: Purchased Oliver No. 7 typewriter, the first in Orient.
1914: Town of Southold and Gardiner's Island flora, co-authored with Burnham, published in *Torreya*.
1915-1920: Worked as commercial fisherman with his father and brothers.
1917: First supplementary list to Southold flora published.
1921: Second supplementary list to Southold flora published.
1922-1940: Burnham worked as Assistant Curator of CU herbarium at Cornell University, identifying further Latham specimens.
1923, 1924, 1925: Third, fourth, and fifth supplements to Southold flora published.
1934: *Flora of the State Park, Orient, Long Island, N.Y.*, published in *Torreya*.
1936: Married Lulah Mae Vail.
1938: Great hurricane hit Long Island.
1943, 25 September: Death of Burnham at Hudson Falls, New York. Deposit of Burnham's 75,000-specimen herbarium, containing many significant Latham collections, in CU and CUP.
1944: Another great hurricane hit eastern Long Island.
1945-1948: Publications in *The Bryologist* on *Cetraria arenaria* on eastern Long Island.
1949: Paper on *Cladina stellaris* published in *The Bryologist*.
1964: Retired from potato farming.
1966: Imshaug and Brodo named *Lecanora caesiorubella* ssp. *lathamii* for Latham.
1968: Brodo's *Lichens of Long Island* published, citing Latham's lifelong accumulation of lichen specimens.
1968-1978: Corresponded with Frederick C. Schlauch, Editor of Northeastern Field Naturalists' Society publications, resulting in over 100 papers in *Engelhardtia* and *The Pitch Pine Naturalist*.
1968: 100,000-specimen insect collection given to Cornell University.
1969: Personal herbarium and zoological collection (except insects) given to the New York State Museum.
1971: Schlauch published a tribute to Latham in *Long Island Forum*.
1977: Thomas S. Zawyrucha interviewed Latham and published a story about him in *Wetlands*.
1979, 13 November: Died at home in Orient.

MYCOTAXON

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A MONOGRAPH OF *CYLINDROCLADIUM*, INCLUDING ANAMORPHS OF *CALONECTRIA*

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ABSTRACT

The genus *Cylindrocladium* and respective teleomorphs in the holomorph genus *Calonectria* are treated. The genera are circumscribed, while morphological characters of conidia, vesicles, phialides, stipes, conidiophore branches and cultural characteristics are compared under standardized conditions. Species are described and illustrated with reference to their pathogenicity and distribution. Comparisons are also made of perithecia, asci and ascospores of the *Calonectria* spp. Comparisons with type specimens, cultures and additional collections of various species worldwide are included. In *Cylindrocladium*, 22 species and one variety, *C. colhounii* var. *macroconidialis*, are recognized. Microconidial states are newly described for *C. ilicicola*, *C. reteaudii* and *C. quinqueseptatum*. Fifteen *Calonectria* species and one variety, *Calonectria colhounii* var. *macroconidialis*, are recognized. Dichotomous and synoptic keys are also provided.

SPECIES TREATED

1. *C. avesiculatum* Gill, Alfieri & Sobers
2. *C. candelabrum* Viegas
3. *C. citri* (Fawcett & Klotz) Boedijn & Reitsma
4. *C. clavatum* Hodges & May
5. *C. colhounii* Peerally var. *colhounii*
6. *C. colhounii* var. *macroconidialis* Crous, Wingfield & Alfenas

7. *C. curvatum* Boedijn & Reitsma
8. *C. floridanum* Sobers & Seymour
9. *C. gracile* (Bugnicourt) Boesewinkel
10. *C. hawksworthii* Peerally
11. *C. heptaseptatum* Sobers, Alfieri & Knauss
12. *C. ilicicola* (Hawley) Boedijn & Reitsma
13. *C. naviculatum* Crous & Wingfield
14. *C. ovatum* El-Gholl, Alfenas, Crous & Schubert
15. *C. parasiticum* Crous, Wingfield & Alfenas
16. *C. pteridis* Wolf
17. *C. quinqueseptatum* Boedijn & Reitsma
18. *C. reteaudii* (Bugnicourt) Boesewinkel
19. *C. scoparium* Morgan
20. *C. spathiphylli* Schoulties, El-Gholl & Alfieri
21. *C. spathulatum* El-Gholl, Kimbrough, Barnard, Alfieri & Schoulties
22. *C. theae* (Petch) Subramanian
23. *C. variabile* Crous, Janse, Victor, Marais & Alfenas

INTRODUCTION

The genus *Cylindrocladium* Morgan was first described in 1892 for *C. scoparium* Morgan (Morgan, 1892). Boedijn & Reitsma (1950) recognized seven species, and in a recent review (Peerally 1991a), 26 species were accepted. *Cylindrocladium* spp. have been associated worldwide with numerous plant hosts, causing a wide range of disease symptoms. Disease development is generally more prevalent under humid conditions, and this explains why *Cylindrocladium* spp. are regarded as more important in tropical and subtropical areas (Crous *et al.*, 1991).

In the original description of *Cylindrocladium* (Morgan 1892), no mention was made of the stipe and characteristic terminal vesicle, now considered typical of this genus. In the first review of *Cylindrocladium*, Boedijn & Reitsma (1950) mentioned that all the species had a vesicle, and they also illustrated these structures as differing in shape. Although Peerally (1991a) distinguished one *Cylindrocladium* sp. by its apparent inability to form a stipe and vesicle, the concept of *Cylindrocladium sensu lato* is one of a fungus having a septate stipe and an apical vesicle (Crous *et al.*, 1993b).

Many species of *Cylindrocladium* are known to have teleomorphs in the holomorph genus *Calonectria* De Not. Rossman (1983) studied the various *Calonectria* spp. with *Cylindrocladium* anamorphs. She was not able to distinguish all *Cylindrocladium* spp. by their teleomorphs, and therefore also rejected the vesicle as a criterion for distinguishing the various anamorph species. In some studies of *Cylindrocladium* (Sobers & Alfieri, 1972; Peerally, 1991a), vesicle morphology was found to be a reliable characteristic for species separation, while others (Zumpetta, 1976; Hunter & Barnett, 1978; Rossman, 1983) found it variable and unreliable, preferring to give preference to conidial characteristics. Recent studies (Crous *et al.*, 1992) have, however, shown that vesicle shape is influenced by the osmotic potential of the growing medium, and that it is a reliable criterion when examined on standardized media under prescribed growth conditions.

Boesewinkel (1982a) found that several of the small-spored *Cylindrocladium* species could be distinguished from the rest on the basis of cultural criteria, chlamydospore arrangement, two types of conidiophores, a *Nectria* (Fr.) Fr. holomorph, and a non-septate stipe. He accordingly transferred five species to a new genus, *Cylindrocladiella* Boesewinkel.

In his most recent review of *Cylindrocladium*, Peerally (1991a), treated the genus *Cylindrocladiella* as a synonym, and recognized 26 species. However, in our opinion, five species would be better accommodated in *Cylindrocladiella*, a genus we consider to be distinct from *Cylindrocladium* (Samuels *et al.*, 1991; Crous & Wingfield, 1993). Crous *et al.* (1991) found reference in the literature to six species of *Cylindrocladiella* and 34 of *Cylindrocladium*. In this study only the species of *Cylindrocladium* are considered in detail. *Cylindrocladiella* spp. have been treated elsewhere (Crous & Wingfield, 1993). Both teleomorph and anamorph characteristics are considered and illustrated. Keys to accepted species are also provided.

MATERIALS AND METHODS

Material examined

Standardization, both of media and conditions of incubation, are critical when studying and describing *Cylindrocladium* spp. (Crous *et al.*, 1992). Various media and different periods of incubation have previously been used by authors describing *Cylindrocladium* spp. Because of this variation, dried type specimens were inadequate for this study. Therefore, in addition to type specimens, type cultures (where available) and additional cultures were examined under standardized conditions.

Abbreviations used for herbaria are those cited by Holmgren & Kreuken (1974). Where type specimens were devoid of material, or depauperate, the original line drawings were redrawn, and the respective authors credited. All cultures and dried, colonized, pieces of carnation-leaf agar (CLA) (Fisher *et al.*, 1982; Crous *et al.*, 1992) were lodged at the National Collection of Fungi, Pretoria (**PREM**). A separate culture collection has been maintained at the Department of Plant Pathology, University of Stellenbosch (**CPC**), at 25 C on malt-extract agar (MEA) slants (20 g Oxoid malt extract, 15 g Difco agar, 1000 ml H_2O), on sterile soil, and under H_2O.

Evaluation of anamorphs

Single-conidial isolates were transferred to CLA, incubated at 25 C under near-ultraviolet lighting, and examined after 7 d. Only material occurring on the surface of the carnation leaves was examined. Material for microscopic examination was mounted in lactophenol containing cotton blue. Wherever possible, fifty examples of each structure were measured, means given, and extreme values placed in parentheses.

Evaluation of teleomorphs

Perithecia were derived from herbarium material as well as from fresh cultures. After material of anamorphs had been prepared for microscopic examination, plates were sealed and incubated until perithecia formed. Perithecia were examined before ascospores were released. This was because changes in spore length, septation and the degree of septal constriction were found to occur in older ascospores. Perithecia were placed in 5% KOH for 2-12 h, and fixed in 5% glutaraldehyde for 12-24 h. They were subsequently washed in H_2O, and placed in a gelatine solution (12.5 g gelatine, 37.5 ml H_2O, 0.5 g phenol). Longitudinal sections 10-15 μm thick were made using a Leitz Kryomat 1703 freezing microtome. Squash mounts were prepared in lactophenol cotton blue and 3% aqueous KOH.

Cultural criteria

Growth studies. To determine the maximum radial growth, agar plugs from 7-day-old colonies (3 mm diam.) of each fungus were placed at the centre of MEA plates and incubated at 25 C for 1 d to ensure active growth. After 1 d, the amount of growth was marked, and all isolates were incubated concurrently at 5, 8, 10, 15, 20, 25, 30, 33, and 35 C with three replicate plates of each culture at every temperature. It was therefore necessary to include these temperatures to establish minimum and maximium temperature requirements for growth. Because most *Cylindrocladium* spp. have an optimum growth between 25 and 30 C, growth was also assessed after 3 d at these temperatures to determine the value of this rapid method in species differentiation. Radial growth was assessed after incubation for 6 d in the dark. Average growth was calculated as an average of four colony radii on each of the three plates. The experiment was repeated at least once for all isolates. Species that grew below 10 C were considered low temperature species, while those that grew above 30 C were regarded as high temperature species.

Chlamydospores and colony colour. This characteristic is of limited taxonomic value in *Cylindrocladium*, as most species form numerous, dense chlamydospore masses. There are, however, exceptions, which will be discussed for individual species. Chlamydospore measurements were found to be unreliable in this study, and were therefore excluded. Colony colours and chlamydospore formation were determined after 6 d. Colour designations used were those of Rayner (1970) and Methuen (Kornerup & Wanscher, 1967).

EVALUATION OF MORPHOLOGICAL CHARACTERS

Anamorph

Vesicle shape and stipe length. Vesicles in *Cylindrocladium* were measured and illustrated (Appendix 1) after cultures were incubated on CLA for 7 d at 25 C under near-ultraviolet light. Because stipes frequently branch in this genus, only terminal vesicles on primary stipes were considered. Only vesicles that were on stipes which had at least one primary and secondary branch with phialides, were included in measurements. Vesicles that showed signs of further proliferation were ignored. Vesicle length was found to be highly variable, but widths were reliable for taxonomic evaluation. Vesicles were often absent in microconidial states.

Although Boesewinkel (1982b) erected new species on the basis of stipe septation, there does not necessarily appear to be a relationship between length and septation of stipes. Species with longer conidia do, however, tend to have longer stipes. Vesicle shape and stipe length (from highest primary branch to the vesicle tip) should thus be seen as additional criteria of taxonomic value in *Cylindrocladium*.

Microconidia. At the outset of this study, five *Cylindrocladium* species, *C. pteridis*, *C. heptaseptatum*, *C. ovatum*, *C. parasiticum*, and *C. variabile* were known to have microconidial states (Sobers, 1968; El-Gholl *et al.*, 1987; Crous *et al.*, 1993b; Crous *et al.*, 1993e; El-Gholl *et al.*, 1993). Microconidial states are here reported for three more: *C. quinqueseptatum*, *C. ilicicola* and *C. reteaudii*. The relationship between the microconidial and macroconidial state in *Cylindrocladium* is poorly understood. The microconidial state does, however, tend to have the same vesicle morphology as that of the macroconidial state.

Phialides and collarettes. *Cylindrocladium* spp. have only penicillate conidiophores. They rarely form collarettes (*sensu* Sutton, 1980) on macrophialides, although collars (*sensu* Booth & Murray, 1960) and channels (*sensu* Sutton, 1980) are often visible. We found that small-spored species have doliiform to reniform phialides. Species with conidia of medium length tended to have slightly elongate, doliiform to reniform phialides. In the large-spored species, phialides were cylindrical to allantoid (rarely doliiform) (Appendix 1, Table 1). Phialide shape in *Cylindrocladium* can therefore be related to conidium septation. A prediction concerning ascospore morphology can also be made (Table 1).

Teleomorph

Ascocarp. Ascocarps of *Calonectria* spp. range from yellow to orange, orange-red, red or red-brown, becoming blood-red in 3% KOH. In *C. colhounii*, only the lower part of the ascocarp changes colour. Ostioles are periphysate, and ascocarps generally become papillate with age.

Calonectria spp. have perithecia with a rough, warty outer layer. Although *Nectria* spp. also have walls consisting of two layers, the outer layer is generally not as rough as that of *Calonectria* spp. However, there appears to be considerable variation in this characteristic, as is evident from *Nectria* spp. recently described by Samuels & Brayford (1990).

Very few differences in stromatal morphology were observed among species of *Calonectria*. Ostiolar periphyses were also found in all perithecia. Ascocarps should be examined just before the ostiolar region becomes lighter in colour and more papillate, as this indicates the onset of ascospore discharge.

Asci and ascospores. Asci are unitunicate, and dissolve at maturity. Few distinct differences in ascospore size occur among species. Generally, species can be separated into those with small, medium or large ascospores. These can then be considered in conjunction with ascospore septation. Small ascospores tend to be 1-septate. Medium-sized ascospores are generally 1-3-septate, and large ascospores 3-septate. These characteristics can also be correlated with conidial septation. For

Table 1. Morphological characters of *Cylindrocladium* spp. with *Calonectria* teleomorphs

Species	Conidial septation[a]	Ascospore septation[b]	Phialide class[c]
C. candelabrum	1	1	1
C. scoparium	1	1	1
C. floridanum	1	1	1
C. gracile	1	1	1
C. avesiculatum	1	1	2
C. pteridis	1(-3)	1(-3)	2
C. spathulatum	1(-3)	1(-3)	2
C. spathiphylli	1(-3)	1(-3)	2
C. ilicicola	(1-)3	1(-3)	2
C. crotalariae	(1-)3	1(-3)	2
C. colhounii var. *colhounii*	(1-)3	(1-)3	2
C. variable	(1-)3(-4)	1(-3)	2
C. colhounii var. *macroconidialis*	(1-)3	(1-)3	3
C. theae	(1-)3	(1-)3	3
C. reteaudii	(1-)3(-6)	(1-)3	3
C. quinqueseptatum	(1-)5(-6)	(1-)3	3

[a] Determined on carnation-leaf agar incubated for 7 d at 25 C under near-ultraviolet light.

[b] Determined before ascal dehiscence.

[c] 1 = Doliiform to reniform; 2 = elongate doliiform to reniform; 3 = cylindrical to allantoid.

example, species with 1-septate ascospores have 1-septate conidia, those with 1-3-septate ascospores have 1-3-septate conidia, and species with 3-septate-ascospores have 3- to multi-septate conidia (Table 1).

KEYS

Both synoptic and dichotomous keys to species of *Cylindrocladium* are presented. In the synoptic key, numbers grouped with each character refer to the species that are alphabetically arranged in the text and in the table of contents.

Key to related anamorph genera

1 Conidia hyaline, 0-multi-septate, cylindrical with obtuse ends, in clear slimy masses, stipe extension present . 2
1 Conidia hyaline, 0-1-septate, cylindrical with obtuse ends, in yellowish slimy masses, stipe extension absent .... *Gliocladiopsis*
2 Stipe septate, microsclerotia common on MEA, cultures not slimy on MEA, phialide collarettes absent on CLA, associated ascocarp with warty outer layer .... *Cylindrocladium*
2 Stipe non-septate, microsclerotia uncommon on MEA, cultures mostly slimy on MEA, phialide collarettes present on CLA, associated ascocarp with smooth outer layer.................. *Cylindrocladiella*

Synoptic key to **Cylindrocladium** *species*

1. Vesicle shape:
    1.1. avesiculate to clavate (Fig. 1B; Appendix 1)
    1
    1.2. clavate to spathulate (Figs 12A, 21A)
    12, 21
    1.3. clavate (Figs 4A, 6A)
    4, 5, 6, 9, 11, 16, 17, 22
    1.4. ellipsoidal to pyriform to obovoid (Figs 10A, 19A)
    3, 10, 19
    1.5. ellipsoidal to ovoid (Fig. 14C)
    14
    1.6. ellipsoid to obpyriform (Fig. 2B)
    2, 18
    1.7. sphaeropedunculate (Figs 8B, 15B)
    7, 8, 15, 23

1.8. globose (Fig. 20A)
20
1.9. naviculate (Fig. 13B).
13

2. Stipe length (mean in μm):
2.1. 120-150
3
2.2. 151-189
2, 8, 12, 13, 15, 19, 21, 23
2.3. 181-210
4, 5, 10, 14, 18
2.4. 211-240
9, 16, 20
2.5. 241-280
1, 6, 17
2.6. 381-650
11, 22

3. Shape of phialides on penicillate conidiophores:
3.1. reniform to doliiform (Figs 2, 3; Appendix 1)
2, 3, 4, 8, 9, 10, 13, 14, 19
3.2. elongate reniform to doliiform (Figs 16, 20)
1, 5, 7, 12, 15, 16, 20, 21, 23
3.3. cylindrical to allantoid (Figs 11, 17)
6, 11, 17, 18, 22

4. Sporulation on aerial mycelium:
4.1. slight to absent
5, 6, 15, 17, 22
4.2. moderate sporulation
1, 2, 3, 4, 8, 9, 10, 11, 12, 13, 14, 16, 18, 19, 20, 21, 23

5. Conidium septation:
5.1. 1-septate
1, 2, 4, 7, 8, 9, 10, 13, 19
5.2. 1(-3)-septate
14, 16, 20, 21
5.3. (1-)3-septate
3, 5, 6, 12, 15, 22, 23
5.4. (1-)3(-6)-septate
18
5.5. (1-)5(-6)-septate
17

5.6. (1-)7(-8)-septate
11

6. Conidium width (mean in μm):
6.1. 3-4
2, 3, 7, 8, 10, 13, 19
6.2. 4.5-5
1, 4, 5, 9, 12, 14, 16, 21, 23
6.3. 5.5-6
15, 18, 20, 22
6.4. 6.5-7
6, 17
6.5. above 7
11

7. Conidium length (mean in μm):
7.1. 40-46
2, 4, 7, 8, 13, 19
7.2. 47-55
3, 12
7.3. 56-66
1, 3, 5, 9, 10, 14, 15, 21, 23
7.4. 67-75
20
7.5. 67-95
16, 17, 18, 22
7.6. above 96
6, 11

8. Chlamydospores on MEA:
8.1. density medium (colonies light brown in colour)
3, 6, 13, 18, 21
8.2. extensive (colonies dark brown in colour)
1, 2, 4, 5, 8, 9, 10, 11, 12, 14, 15, 16, 17, 19, 20, 22, 23

9. Temperature requirement for minimum growth (C):
9.1. below 5
3, 21
9.2. 5-8
2, 10, 13, 19, 23
9.3. 8-10
1, 5, 6, 8, 12, 15, 18
9.4. above 10
4, 9, 11, 14, 16, 17, 20, 22

10. Temperature requirement for optimum growth (C):
    - 10.1. 25
      1, 3, 4, 5, 6, 11, 12, 13, 14, 15, 17, 18, 20, 21, 22, 23
    - 10.2. 25-30
      2, 8, 19
    - 10.3. 30
      9, 10
    - 10.4. 30-33
      16
11. Maximum temperature permitting growth (C):
    - 11.1. below 33
      3, 5, 6, 11, 21
    - 11.2. below 35
      1, 4, 10, 12, 17, 18, 20, 22, 23
    - 11.3. above 35
      2, 8, 9, 13, 14, 15, 16, 19
12. Microconidial shape:
    - 12.1. curved (Fig. 16C)
      16
    - 12.2. straight (Fig. 17C)
      11, 12, 14, 15, 17, 18, 23
13. Microconidial length (mean in μm):
    - 13.1. 10-20
      11
    - 13.2. 21-38
      12, 14, 15, 16, 23
    - 13.3. above 39
      17, 18
14. Collarettes on phialides of microconidiophores:
    - 14.1. present (Fig. 12B)
      11, 12, 14, 15
    - 14.2. absent (Fig. 16C)
      16, 17, 18, 23
15. Ascocarps:
    - 15.1. red-brown to red in colour, changing to blood-red in 3% KOH
      2, 9, 16, 19, 23
    - 15.2. orange to red in colour, changing to blood red in 3% KOH
      1, 8, 12, 15, 18, 20, 21, 22

15.3. orange to red-brown in colour,
changing to blood red in 3% KOH
17

15.4. yellow to orange in colour, only base
and stroma changing to blood-red in KOH
5, 6

Dichotomous key to **Cylindrocladium** *species*

1. Conidia only 1-septate 2
1. Conidia with more than one septum present 10
    2. Conidia mostly straight 3
    2. Conidia mostly curved 4
3. Vesicles narrowly avesiculate to clavate,
stipe thick-walled, conidia
(57-)64(-77) x (4-)5(-7) μm .... **1** *C. avesiculatum*
3. Vesicles not as above...5
    4. Conidia 40-46 x 3-4 μm, vesicles
    sphaeropedunculate.......................................**7** *C. curvatum*
    4. Conidia (42-)56(-76) x (3-)4(-5) μm,
    vesicles ellipsoidal to obovoid.............. **10** *C. hawksworthii*
5. Vesicles clavate 6
5. Vesicles not as above...7
    6. Conidia (40-)56(-65) x (4-)5 μm,
    stipes (160-)220(-350) μm...................................**9** *C. gracile*
    6. Conidia (38-)45(-52) x (4-)5(-6) μm,
    stipes (140-)200(-260) μm.............................**4** *C. clavatum*
7. Vesicles sphaeropedunculate, conidia
(35-)40(-50) x (3-)4(-5) μm ....**8** *C. floridanum*
7. Vesicles not as above...8
    8. Vesicles ellipsoidal to pyriform
    (widest above the middle), conidia
    (40-)45(-55) x (3-)4(-5) μm........................ **19** *C. scoparium*
    8. Vesicles not as above..9
9. Vesicles ellipsoidal to obpyriform
(widest below the middle), conidia
(33-)45(-58) x (3-)4(-5) μm ....**2** *C. candelabrum*
9. Vesicles naviculate, conidia
(40-)43(-55) x (3-)4 μm .... **13** *C. naviculatum*
    10. Average conidial septation, one 11
    10. Average conidial septation more than one 14

11. Vesicles mostly globose, conidia (48-)68(-104) x (5-)6(-7) μm .... **20** *C. spathiphylli*
11. Vesicles not as above 12
    12. Vesicles ovoid, conidia (36-)65(-80) x (4-)5(-6) μm .... **14** *C. ovatum*
    12. Vesicles not as above 13
13. Vesicles clavate to spathulate, conidia (48-)58(-75) x (4-)5(-6) μm .... **21** *C. spathulatum*
13. Vesicles narrowly clavate, conidia (62-)82(-121) x 5(-6) μm .... **16** *C. pteridis*
    14. Conidia (1-)3-septate 15
    14. Conidia more than 3-septate 21
15. Vesicles clavate 16
15. Vesicles not as above 18
    16. Phialides doliiform to reniform, conidia (45-)59(-70) x (4-)5(-6) μm, stipes (160-)210(-280) μm .... **5** *C. colhounii* var. *colhounii*
    16. Phialides cylindrical to allantoid 17
17. Conidia (65-)81(-96) x (5-)6(-7) μm, stipes (340-)380(-600) μm .... **22** *C. theae*
17. Conidia (86-)97(-112) x (5-)7(-8) μm, stipes (240-)280(-320) μm .... **6** *C. colhounii* var. *macroconidialis*
    18. Vesicles uniformly sphaeropedunculate, conidia (45-)62(-90) x (4-)6(-7) μm .... **15** *C. parasiticum*
    18. Vesicles not as above 19
19. Vesicles sphaeropedunculate, ellipsoid to clavate, conidia (48-)60(-75) x (4-)5(-6) μm, frequently curved .... **23** *C. variabile*
19. Vesicles not sphaeropedunculate, but clavate to spathulate to obovoid 20
    20. Chlamydospores in medium numbers, a low temperature species .... **3** *C. citri*
    20. Chlamydospores extensive, a high temperature species .... **12** *C. ilicicola*
21. Conidia (1-)3(-6)-septate, vesicles clavate to ellipsoidal to ovoid, conidia (60-)80(-105) x (5-)6(-7) μm .... **18** *C. reteaudii*

21. Average conidial septation more than three 22
    22. Conidia (61-)84(-101) x (5-)7 μm ....17 *C. quinqueseptatum*
    22. Conidia (96-)118(-144) x (6-)8(-9) μm ....11 *C. heptaseptatum*

CYLINDROCLADIUM

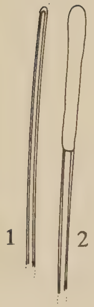
Cylindrocladium Morgan *Bot. Gaz.* **17:** 191 (1892).
Candelospora Hawley apud Rea & Hawley *Proc. R. Irish Acad.* **31:** 11 (1912).
Tetracytum Vanderwalle *Parasitica* **1:** 145 (1945).
Type species: *C. scoparium* Morgan
Holomorph: **Calonectria** De Not. (*C. pyrochroa* (Desm.) Sacc.)
Descriptions: Boedijn & Reitsma, 1950; Hunter & Barnett, 1978; Rossman, 1983.

Macroconidiophores hyaline, penicillate, frequently with pigmented base, arising at right angles to the substrate. *Stipe* septate, hyaline, tapering towards apex, refered to as the stipe, frequently in the middle or to the side of the conidiophore, branched or unbranched, giving rise to a terminal, thin-walled structure of characteristic shape, called the vesicle. *Conidiophore branches* hyaline, penicillate, branching up to six times. *Monophialides* hyaline, with collars, doliiform or reniform to cylindrical or allantoid, occurring singly, or in groups of up to five on the ends of branches. *Conidia* hyaline, cylindrical, straight or curved, 1-8-septate with obtuse ends, mostly encased in an irregular mucilaginous matrix, arranged in cylindrical conidial clusters. *Chlamydospores* dark brown, thick-walled, occurring in clusters or chains, forming microsclerotia in soil, debris, host tissue and culture media.

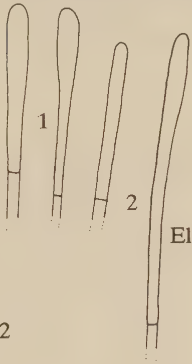
Microconidiophores hyaline, penicillate or subverticillate, occurring mixed with macroconidiophores. *Stipe* hyaline, septate, cylindrical or with apical taper, terminating in a whorl of phialides or apical vesicle. *Conidiophore branches* hyaline, cylindrical, branching up to three times. *Monophialides* hyaline, cylindrical, frequently with conspicuous collarettes. *Conidia* hyaline, 1-septate, cylindrical with obtuse ends, curved or straight.

Teleomorph. Species either homothallic or heterothallic. *Perithecia* solitary or gregarious, superficial, with periphysate ostiolar region, yellow to orange to red or red-brown, turning blood-red in 3 %

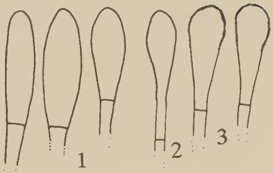
APPENDIX 1
VESICLE AND PHIALIDE SHAPES



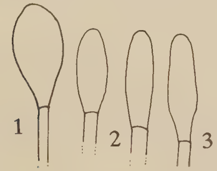
Avesiculate^1 to clavate^2



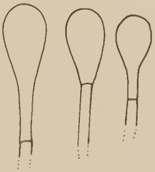
Clavate^1 to narrowly clavate^2



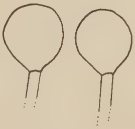
Ellipsoidal^1 to pyriform^2 or obovoid^3



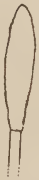
Ovoid^1 to ellipsoidal^2
to obpyriform^3
or spathulate^3



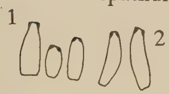
Sphaeropedunculate



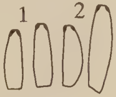
Globose



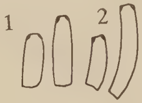
Naviculate



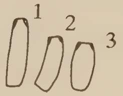
Doliiform^1 to
reniform^2



Elongated
doliiform^1
to reniform^2



Cylindrical^1
to allantoid^2



Cylindrical^1 to allantoid^2
to doliiform^3

Avesiculate to clavate vesicles, *C. avesiculatum;* **Clavate to narrowly clavate vesicles,** *C. clavatum, C. colhounii, C. gracile, C. hawksworthii, C. heptaseptatum, C. ilicicola, C. pteridis, C. quinqueseptatum, C. spathulatum, C. theae, C. variabile;* **Ellipsoidal to pyriform or obovoid vesicles,** *C. hawksworthii, C. reteaudii, C. scoparium, C. variabile;* **Ovoid to ellipsoidal to obpyriform or spathulate vesicles,** *C. candelabrum, C. citri, C. ilicicola, C. ovatum, C. spathiphylli, C. spathulatum;* **Sphaeropedunculate vesicles,** *C. curvatum, C. floridanum, C. parasiticum, C. variabile;* **Globose vesicles,** *C. spathiphylli;* **Naviculate vesicles**, *C. naviculatum.*

KOH. *Ascocarp* wall consisting of two regions. The outer wall having large, globose cells, giving rise to a warty appearance. The inner layer consisting of hyaline, thin-walled elongate cells. *Asci* unitunicate, without apical mechanism, evanescent at maturity, clavate, tapering to a long thin basal stalk. *Ascospores* usually aggregated in upper third of ascus, bi- to multi-seriate, hyaline, straight to fusoid or ellipsoidal, one- to multi-septate, not or slightly constricted at septa, (1-4-)8 per ascus.

Generic synonyms

Boedijn & Reitsma (1950) reduced the genus *Candelospora* to synonymy with *Cylindrocladium*. They subsequently also made new combinations for two species, *Candelospora ilicicola* Hawley and *Candelospora citri* Fawcett & Klotz. Tubaki (1958) followed this decision by placing *Candelospora penicilloides* Tubaki in *Cylindrocladium*. Tubaki (1958) recognized the similarity between the genus *Moeszia* Bubak and *Cylindrocladium*. Later, Von Arx (1970) reduced *Moeszia* to synonymy with *Cylindrocarpon* Wollenw. *Tetracytum* Vanderwalle, with type species *T. laurii* Vanderwalle (1945) was recognized as a synonym of *Cylindrocladium* (Subramanian, 1971; Domsch *et al.*, 1980). *T. laurii* was thus synonymized with *C. ilicicola* (Meyer, 1959). The similarity of these two fungi was also recognized by Brayford & Chapman (1987).

Although *Diplocladium* Bonord. was never considered to be a synonym of *Cylindrocladium*, two species originally described in *Diplocladium* were later transferred to *Cylindrocladium*. These are *D. cylindrosporum* Ellis & Everh. (Ellis & Everhart, 1900) a synonym of *C. scoparium* (Boedijn & Reitsma, 1950) and *D. gregarium* Bres. (Bresadola, 1903), which was wrongly placed in *Cylindrocladium* by de Hoog (1978). The genus *Diplocladium* has, however, been synonymized with *Cladobotryum* Nees (Barron, 1968).

SPECIES

1. **Cylindrocladium avesiculatum** Gill, Alfieri & Sobers

Phytopathology **61:** 60 (1971).
Holomorph: **Calonectria avesiculata** Schubert, El-Gholl, Alfieri & Schoulties *Can. J. Bot.* **67:** 2415 (1989).
Illustrations: Figs 1, 24, 25; Gill *et al.*, (1971); Schubert *et al.* (1989).
Descriptions: Gill *et al.*, (1971); Schubert *et al.* (1989).

Macroconidiophores. *Stipe* septate, hyaline, terminating in an avesiculate to clavate vesicle, (1-)3(-4) μm diam.; stipes (190-)265(-360) μm long. *Conidiophore branches*: primary branches

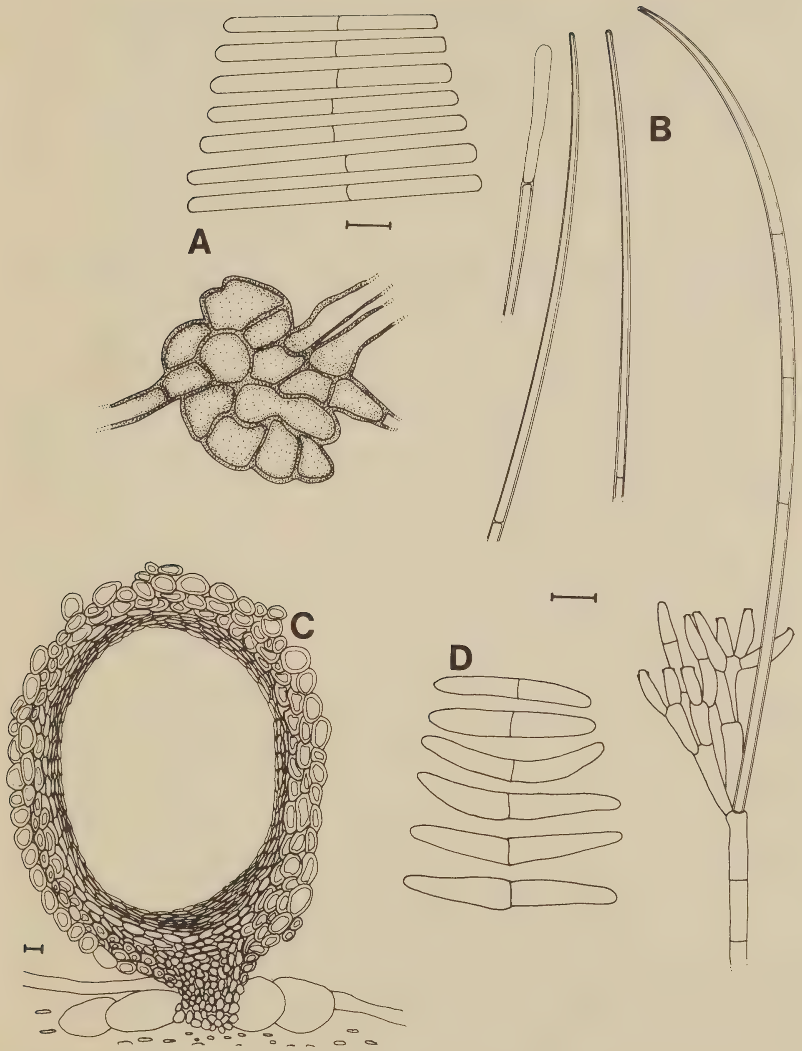


Fig. 1A-D. *Calonectria avesiculata* and its *Cylindrocladium avesiculatum* anamorph (bar = 10 μm). A, conidia and microsclerotium; B, clavate vesicles, avesiculate stipes and conidiophore on CLA (**ATCC** 38226, *ex* type); C, v.s. through a perithecium; D, ascospores (**F** 55193, type).

non-septate or rarely 1-septate, (13-)17(-25) x (4-)5 μm; secondary branches non-septate, (10-)13(-15) x 4(-5) μm; tertiary branches non-septate, rarely observed, (8-)12(-13) x (3-)4(-5) μm. *Phialides* elongate, doliiform to reniform, hyaline, non-septate, (9-)12(-16) x (3-)4(-5) μm. *Conidia* cylindrical, hyaline, 1-septate, rounded at both ends, (57-)64(-77) x (4-)5(-7) μm. *Microconidiophores* unknown.

Cultural characteristics. *Temperature* min. above 8 C; max. below 35 C; opt. 25 C. This is a high temperature species, with medium sporulation on aerial mycelium. *Colony colour* (reverse) 13K amber brown (Rayner, 1970), 6D8 light brown (Kornerup & Wanscher, 1967). *Chlamydospores* extensive, dense, forming large microsclerotia.

Teleomorph. *Perithecia* globoid, red to orange-red in colour, 340-520 x 300-500 μm, with warty outer wall and papillate ostiole, turning blood-red in 3 % KOH. *Asci* hyaline, clavate, 82-190 x 13-30 μm, tapering to a long thin stalk, containing eight ascospores. *Ascospores* hyaline, straight or falcate, 1-septate, not or slightly constricted at central septum, (22-)40(-50) x (4-)6(-7) μm.

Type: USA: Georgia, Cairo, *Ilex cornuta* Lindl. & Paxt. leaves, D. Gill, 27 May 1969, **BPI** 414546 (isosyntype of anamorph); Florida, Gainsville, *I. vomitoria* Soland. leaves, T. Schubert, Oct. 1986, **FLAS** F55193 (holotype of teleomorph).
Symptoms: leaf spotting, twig die-back and defoliation (Gill *et al.*, 1971).
Hosts: *Ilex* spp., *Pyrancantha coccinea* M. Roem., *Rhododendron obtusum* Planch. (Gill *et al.*, 1971).
Distribution: U.S.A. (Georgia, Florida) (Schubert *et al.*, 1989).
Specimens: USA: Georgia, Cairo, *Ilex cornuta* leaves, D. Gill, 27 May 1969, **BPI** 414546 (isosyntype of anamorph); Georgia, Cairo, *Ilex vomitoria* leaves, 27 May 1969, **BPI** 414547; Florida, Gainsville, *I. vomitoria* leaves, T. Schubert, Oct. 1986, **FLAS** F55193 (holotype of teleomorph).
Culture: USA: Georgia, Cairo, *Ilex vomitoria*, S.A. Alfieri, 1971, ATCC 38226.
Notes: *C. avesiculatum* is characterized by having large 1-septate conidia, and thick-walled avesiculate stipes. The nature of the stipe is unique to this species.

Gill *et al.* (1971) refer to *C. simplex* Meyer and *C. simplex* var. *microchlamydosporum* Meyer which are avesiculate, with stipes terminating in a slight swelling (Meyer, 1959). These two fungi are not

Cylindrocladium spp., and were transferred to *Gliocephalotrichum* Ellis & Hesseltine (Wiley & Simmons, 1971). Meyer (1959) illustrates a collection of *C. scoparium* from Zaire, which in spite of the slightly smaller conidia (40-48 x 3-4 μm), strongly resembles *C. avesiculatum*. No mention is made of any herbarium specimens, so this matter cannot be pursued further. Schubert *et al.* (1989) state that *Calonectria avesiculata* is heterothallic.

2. **Cylindrocladium candelabrum** Viegas *Bragantia* **6:** 370 (1946).
Holomorph: **Calonectria scoparia** Ribeiro & Matsuoka *ex* Peerally (1991) *Mycotaxon* **40:** 341.
Calonectria scoparia Ribeiro & Matsuoka (1978) Ribeiro, M. Sc. Thesis, Heterotalismo em *C. scoparium* Morgan p. 28. (*nom. nud.*).
Illustrations: Figs 2, 26, 27; Ribeiro (1978); Ferreira (1989); Botha & Crous (1992).
Descriptions: Ribeiro (1978); Botha & Crous (1992); Crous *et al.* (1993a).

Macroconidiophores. *Stipe* septate, hyaline, terminating in an ellipsoid to obpyriform vesicle (Hawksworth *et al.*, 1983), (6-)8(-10) μm diam; stipes (105-)180(-290) μm long. *Conidiophore branches*: primary branches non-septate or rarely 1-septate, (13-)19(-27) x (3-)4 μm; secondary branches non-septate, (10-)15(-22) x (3-)4 μm; tertiary branches non-septate, (10-)14(-16) x (3-)4 μm. *Phialides* arise from the ends of branches, in groups of 2, 3 or 4; phialides doliiform to reniform, hyaline, (7-)13(-19) x (3-)4 μm. *Conidia* cylindrical, hyaline, 1-septate, rounded at both ends, (33-)45(-66) x (3-)4(-5) μm. *Microconidiophores* unknown.

Cultural characteristics. *Temperature* min. above 5 C; max. above 35 C; opt. 25-30 C. This is a eurythermal species, with medium sporulation on aerial mycelium. *Colony colour* (reverse) (13K-17'I-15"I), amber brown to buckthorn brown to sayal brown (Rayner, 1970), (5D6-6D8 or 5C6-6C7) pompeian yellow to light brown, or oak brown to reddish golden (Kornerup & Wanscher, 1967). *Chlamydospores* extensive, in chains or clusters, forming microsclerotia in moderate numbers.

Teleomorph. *Perithecia* superficial, borne singly or in small groups, globose or subglobose, 280-520 x 280-400 μm, red-brown to red, with rough warted outer wall and papillate ostiole. *Asci* hyaline, clavate, (72-)90(-120) x (6-)8(-15) μm, tapering to a long thin stalk,

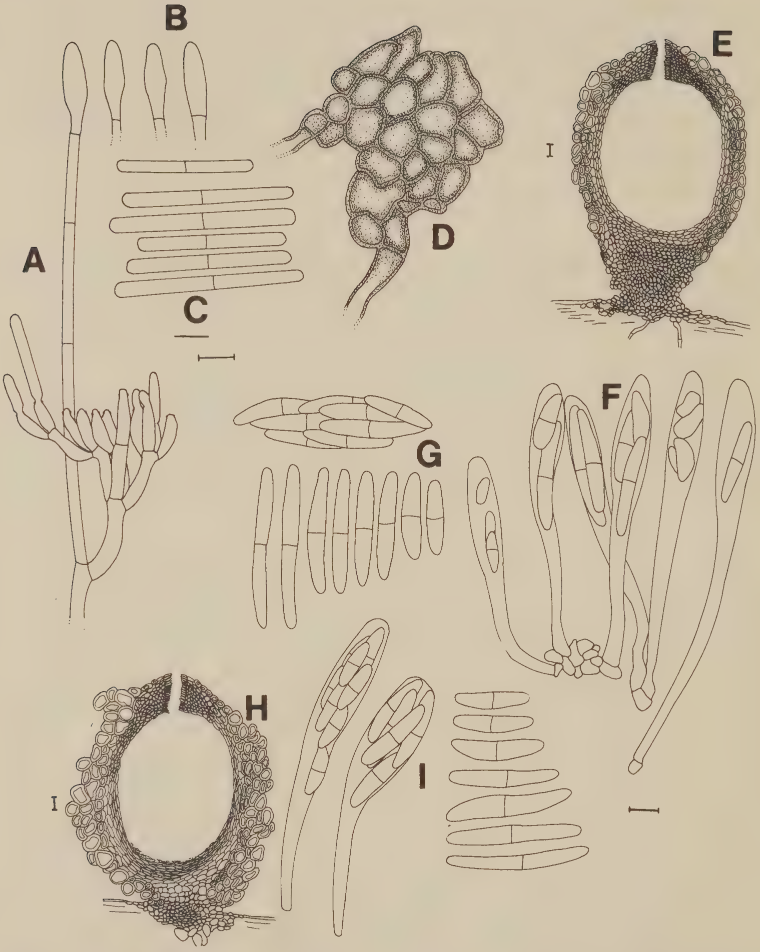


Fig. 2A-I. *Calonectria scoparia* and its anamorph *Cylindrocladium candelabrum*. A, conidiophore; B, obpyriform to ellipsoid vesicles; C, conidia; D, microsclerotium on CLA (**PPRI** 3989); E, v. s. through a perithecium (bar = 20 μm); F, G, asci and ascospores; C, (Brazil X Brazil **PPRI** 4163 x **PPRI** 4153, bar = 10 μm); H, v.s. through a perithecium (bar = 20 μm); I, asci and ascospores (South African x South African **PPRI** 4202 x **PPRI** 4199, bar = 10 μm).

containing 1-8 ascospores. *Ascospores* hyaline, straight to falcate, 1-septate, not or slightly constricted at central septum, (28-)41(-68) x (4-)5(-7) µm. Ascospores becoming 3-septate once discharged from ascus.

Type: Brazil: Copener-Bahia, *Eucalyptus* sp., A.C. Alfenas, **PPRI** 4153, **PREM** 51044 (neotype of anamorph); Brazil, BA Sul, Picadao, Conceicao da Barra, A.C. Alfenas & F.A. Ferreira, *Eucalyptus grandis* clone 172 (branch), 27 Apr. 1992, **PREM** 51045 (neotype of teleomorph).
Symptoms: damping off, root rot, cutting rot, stem cankers, leaf spotting, seedling and shoot blight (Ferreira, 1989).
Hosts: wide host range (Ferreira, 1989; Botha & Crous, 1992).
Distribution: Australia, Brazil, India, Kenya, Mauritius, South Africa.
Specimens: Africa: Kenya, *E. saligna* Sm., I. Gibson, 1966, **IMI** 123734; RSA, E. Tvl., Sabie, Frankfort, *E. grandis* cuttings, A.C. Alfenas, 24 Mar. 1992, **PREM** 51046 (teleomorph occurring naturally on cuttings); RSA, Natal, Cedara, *Syncarpia gummifera* (Smith) Niedz., M.J. Wingfield, 17 July 1978, **PPRI** 45419; **PPRI** 4202 (*E. macarthurii*) x **PPRI** 4199 (*Eucalyptus* sp.), July 1992, P.W. Crous, **PREM** 51050. **Brazil:** *Luma* sp., Campinas, Herbario da Seccao de Botanico **IACM** 440 (holotype of *C. candelabrum*); *Annona* sp., Campinas, Herbario da Seccao de Botanico, **IACM** 8155; **PPRI** 4163 (*Eucalyptus* sp.) x **PPRI** 4153 (*Eucalyptus* sp.), July 1992, P.W. Crous, **PREM** 51047; **PPRI** 4161 (*E. grandis*) x **PPRI** 4153 (*Eucalyptus* sp.), July 1992, P.W. Crous, **PREM** 51048; **PPRI** 4146 (*Eucalyptus* sp.) x **PPRI** 4153 (*Eucalyptus* sp.), July 1992, P.W. Crous, **PREM** 51049. **India:** *Eucalyptus* sp., C. Booth, 1964, **IMI** 108770 (as *C. theobromae*). **Mauritius:** unknown host, M.A. Peerally, **IMI** 167982 (as *C. sclerotiorum*).
Cultures: Africa: RSA: Swellendam, *Medicago truncatula*, S. Lamprecht, 16 March 1986, **PPRI** 3554; Natal, Seven Oaks, debris, 1 Feb. 1990, I. Rong, **PPRI** 3812; Natal, Kwambonambi, *E. grandis*, G. Kemp, May 1990, **PPRI** 3988; E. Tvl., Frankfort, *Eucalyptus* sp., S.H. Koch, 1988, **PPRI** 3989; E. Tvl., White River, *Rhododendron* hybrid, P.W. Crous, 11 May 1990, **PPRI** 4085; Natal, Pietermaritzburg, *E. nitens*, P.W. Crous, March 1991, **PPRI** 4189; Natal, Kwambonambi, *E. grandis*, P.W. Crous, Feb. 1990, **PPRI** 4191; Natal, Kwambonambi, *E. grandis*, P.W. Crous, Feb. 1990, **PPRI** 4192; E. Tvl., White River, *E. grandis*, P.W. Crous, Feb. 1990, **PPRI** 4193; Natal, Pietermaritzburg, *E. fastigata*, P.W. Crous, Feb. 1990, **PPRI** 4194; Natal, Kwambonambi, *Eucalyptus* sp., P.W. Crous, Feb. 1990, **PPRI** 4195; Natal, Kwambonambi, *Eucalyptus* sp., P.W. Crous, May 1990, **PPRI** 4196; E. Tvl., White River, *Eucalyptus* sp., P.W. Crous, 29 Sept.

1989, **PPRI** 4197; E. Tvl., Klipkraal, *E. grandis*, P.W. Crous, Feb. 1990, **PPRI** 4198; E. Tvl., Sabie, D.R. De Wet, *Eucalyptus* roots, P.W. Crous, Feb. 1990, **PPRI** 4199; N. Tvl., Tzaneen, *Eucalyptus* sp., P.W. Crous, 28 June 1990, **PPRI** 4201; Natal, Commondale, M.J. Wingfield, *E. macarthurii*, 5 Jan. 1987, **PPRI** 4202; E. Tvl., *E. nitens* (Deane *et* Maid.) Maid., M.J. Wingfield, ?, **PPRI** 4203; E. Tvl., Sabie, *E. grandis* roots, M.J. Wingfield, ?, **PPRI** 4204; E. Tvl., White River, *E. grandis* cuttings, P.W. Crous, 29 Sept. 1989, **PPRI** 4205; ?, *Acacia cyclops*, M. Morris, 10 July 1990, **PPRI** 4206; Natal, Kwambonambi, *Eucalyptus* leaves, P.W. Crous, May 1990, **PPRI** 4208. **Australia:** Queensland, from strawberry, D. Hutton, **CPC** 517, 518. **Brazil:** MG, Joao Pinheiro, *E. cloeziana*, A.C. Alfenas, **PPRI** 4151; MG, Virginopolis, *Eucalyptus* sp., **PPRI** 4146, **IMI** 354527; Copener-Bahia, *Eucalyptus* sp., **PPRI** 4148; UNB, J.C. Dianese, **PPRI** 4149; Viveiro, *Eucalyptus* sp., A.C. Alfenas, **PPRI** 4150; Copener-Bahia, *Eucalyptus* sp., A.C. Alfenas, **PPRI** 4152; Copener-Bahia, *Eucalyptus* sp., A. C. Alfenas, **PPRI** 4153, **IMI** 354517; ?, UNB, J.C. Dianese, **PPRI** 4155; CAF, *Eucalyptus* sp., A.C. Alfenas, **PPRI** 4156; MG, Ipatinga, *Eucalyptus* sp., A.C. Alfenas, **PPRI** 4158; MG, Ipatinga, *Eucalyptus* sp., A.C. Alfenas, **PPRI** 4159; Viveiro Florestas Rio Doce, *E. grandis*, A.C. Alfenas, **PPRI** 4161; MG, Coronel Fabricano, *Eucalyptus* sp., A.C. Alfenas, **PPRI** 4163 **IMI** 354518; PE, Recife, *Eucalyptus* sp., R.L.R. Mariano, **PPRI** 4165; ES, Aracruz, *Eucalyptus* sp., A.C. Alfenas, **PPRI** 4734.

Notes: this species is morphologically similar to *C. floridanum* and *C. scoparium*. It can, however, be distinguished by its ellipsoidal to obpyriform vesicles. Those of *C. floridanum* and *C. scoparium* are sphaeropedunculate and pyriform respectively (Appendix 1). Furthermore, the total protein electrophoresis banding pattern of *C. candelabrum* can be distinguished from that of *C. scoparium* (Crous *et al.*, 1993a).

Matings of single-conidial isolates from *C. scoparium* cultures have shown that this species does not cross with isolates of *C. candelabrum*. Moreover, isolates of *C. candelabrum* from South Africa and Brazil are sexually compatible, and pairings between and among them result in the formation of the teleomorph (Crous *et al.*, 1993a). The teleomorph is also frequently found associated with diseased *Eucalyptus* cuttings in forest nurseries in South Africa and Brazil.

3. Cylindrocladium citri (Fawcett & Klotz) Boedijn & Reitsma *Reinwardtia* **1:** 57 (1950).
Candelospora citri Fawcett & Klotz *Mycologia* **29:** 213 (1937).
Cylindrocladium penicilloides (Tubaki) Tubaki *Journ. Hattori Bot. Lab.* **20:** 154 (1958).
Candelospora penicilloides Tubaki *Nagaoa* **2:** 58 (1952).
Illustrations: Figs 3, 28, 29; Boedijn & Reitsma (1950).
Descriptions: Fawcett & Klotz, 1937; Boedijn & Reitsma (1950).

Macroconidiophores. Stipe septate, hyaline, terminating in a obovoid to pyriform vesicle, (4-)7(-10) μm diam; stipes (115-)127(-170) μm long. *Conidiophore branches*: primary branches non-septate to 1-septate, (10-)16(-26) x (3-)4(-5) μm; secondary branches non-septate, (10-)11(-12) x (2-)3(-4) μm. *Phialides* doliiform to reniform, hyaline, non-septate, (8-)10(-11) x (3-)4 μm. *Conidia* cylindrical, hyaline, (1-)3-septate, rounded at both ends, (50-)58(-65) x (3-)4(-5) μm. *Microconidiophores* unknown; *Teleomorph* unknown.

Cultural characteristics. Temperature min. below 5 C; max. below 33 C; opt. 25 C. This is a low temperature species, with medium sporulation on aerial mycelium. *Colony colour* (reverse) 13'I tawny (Rayner, 1970), 6D8 light brown (Kornerup & Wanscher, 1967). *Chlamydospores* in medium numbers, scattered throughout the medium or appearing in chains, forming microsclerotia.

Type: USA: Florida, *Citrus sinensis* Pers. fruit, H.S. Fawcett, 1937, **CBS** 186.36 (*ex* type culture).
Symptoms: decay of citrus fruits (Fawcett & Klotz, 1937).
Hosts: Citrus (Fawcett & Klotz, 1937).
Distribution: Florida, U.S.A. (Fawcett & Klotz, 1937).
Cultures: USA: Florida, *Citrus sinensis* fruit, H.S. Fawcett, 1937, **CBS** 186.36. **Japan:** Hatizyo, *Prunus* sp., M. Ookubu, 1952, **CBS** 174.55.
Notes: there have been no reports in the literature of this fungus other than that dealing with its type culture. The vesicles of this species are very variable, as was noted by Zumpetta (1976). Although Boedijn & Reitsma (1950) did not illustrate the exact nature of the vesicle, Sobers & Alfieri (1972) described it as "mostly ellipsoidal". On CLA, they are obovoid to pyriform in shape. However, young vesicles frequently resemble those of *C. ilicicola*. *C. citri* is distinguishable from *C. ilicicola* in being a low temperature species, while the latter is a high temperature species.

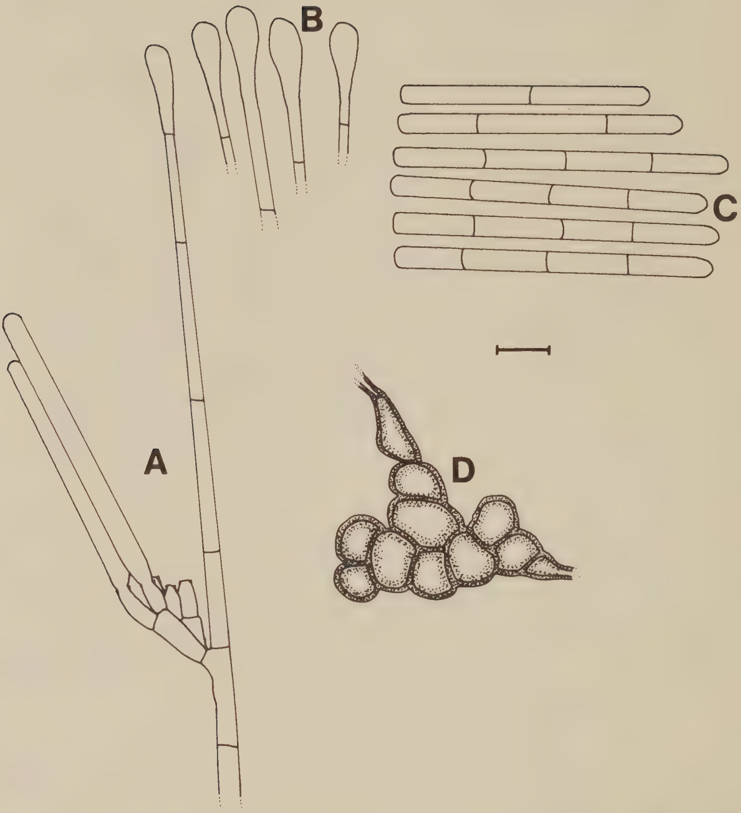


Fig. 3A-D. *Cylindrocladium citri* (bar = 10 μm). A, conidiophore; B, obovoid to pyriform vesicles; C, conidia; D, microsclerotium on CLA (CBS 186.36, *ex* type).

The general morphology and cultural characteristics were found to be similar to that of *C. penicilloides* which was collected from a *Prunus* sp. in Japan in 1952. Further molecular study of the sterile type culture (CBS 174.55) (Crous *et al.*, 1993b), found that although the esterase zymograms showed differences from that of *C. citri* (**CBS** 186.36), the repetitive DNA polymorphisms using three restriction enzymes showed them to be very similar. Because of the similarities in their general morphology, chlamydospore formation, temperature requirements for growth and DNA banding patterns, *C. penicilloides* was reduced to synonymy with *C. citri*.

4. Cylindrocladium clavatum Hodges & May *Phytopathology* **62:** 900 (1972).
Cylindrocladium brassicae Panwar & Bohra *Indian Phytopathology* **27:** 425 (1974).
Illustrations: Figs 4, 30-32; Hodges & May (1972); Peerally (1974b).
Descriptions: Hodges & May (1972); Peerally (1974b).

Macroconidiophores. *Stipe* septate, hyaline, terminating in a clavate vesicle, (3-)5(-6) μm diam.; stipes (140-)200(-260) μm long. *Conidiophore branches*: primary branches non-septate or rarely 1-septate, (10-)16(-25) x (4-)5 μm; secondary branches non-septate, (10-)13(-18) x 4(-5) μm; tertiary branches non-septate, (11-)13(-16) x 4(-5) μm; quaternary branches non-septate, (10-)12(-13) x 4(-5); pentianary branches non-septate, (9-)10(-11) x 4(-5) μm. *Phialides* doliiform to reniform, hyaline, non-septate, (10-)12(-13) x (3-)4(-5) μm. *Conidia* cylindrical, hyaline, 1-septate, rounded at both ends, (38-)45(-52) x (4-)5(-6) μm. *Microconidiophores* unknown; *Teleomorph* unknown.

Cultural characteristics. *Temperature* min. above 10 C; max. below 35 C; opt. 25 C. This is a high temperature species, with medium sporulation on aerial mycelium. *Colony colour* (reverse) 13 K - 17"K amber brown to Saccardo's umber (Rayner, 1970), 6D8 - 5E7 light brown to linoleum brown (Kornerup & Wanscher, 1967). *Chlamydospores* extensive, dense, throughout medium, forming microsclerotia.

Type: Brazil: M.G., Horto Conceicao, near Itabira, *Pinus caribaea* E. Murray roots, Hodges & May, 16 Mar. 1971, **BPI** 414550, 414551.
Symptoms: root rot, leaf spotting, stem infection, seedling blight, tuber rot and shoot blight. This fungus is possibly seed-borne (Bolkan *et al.*,

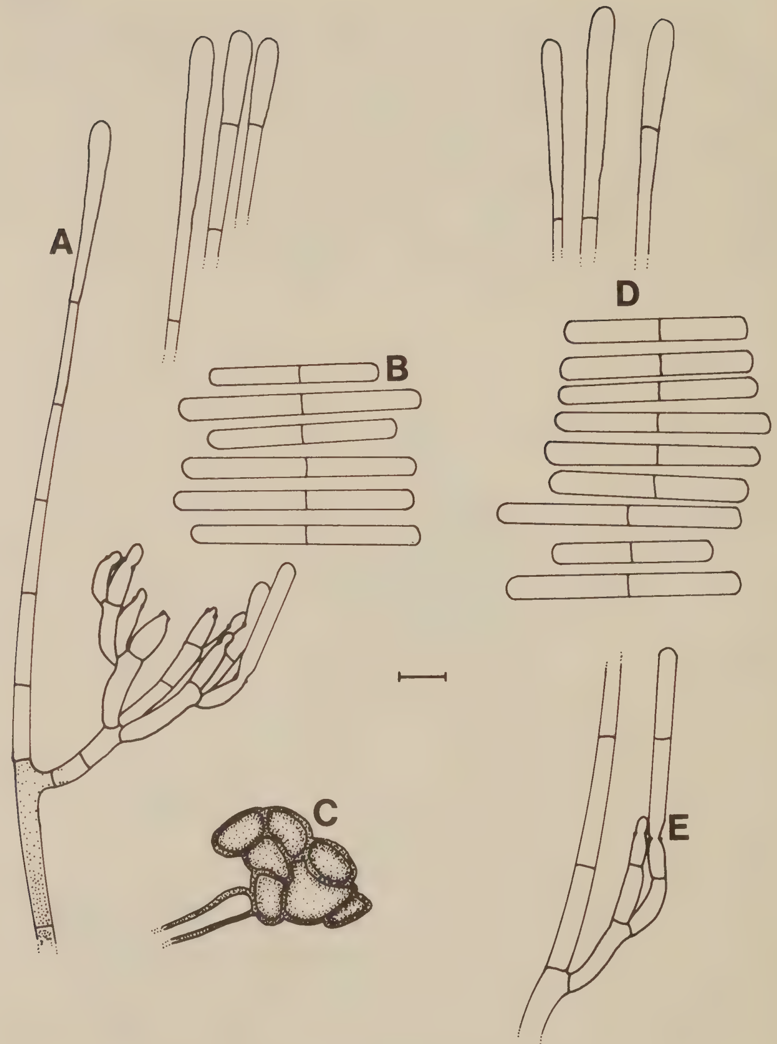


Fig. 4A-E. *Cylindrocladium clavatum* (bar = 10 μm). A, conidiophore and clavate vesicles; B, conidia; C, microsclerotium on CLA (**PPRI** 3997); D, clavate vesicles and conidia; E, conidiophore on agar (**BPI** 414550, type).

1981; Sharma *et al.*, 1984; Sharma *et al.*, 1985; Mohanan & Sharma, 1985a; Rattan *et al.*, 1983; Crous *et al.*, 1993c).

Hosts: *Arachis hypogaea* L., *Araucaria angustifolia* Bertol., *Brassica campestris* L., *Camellia sinensis* (L.) Kuntze, *Capsicum frutenscens* Rodsch., *Cicer arietinum* L., *Eucalyptus* spp., *Glycine max* Merrill, *Pinus* spp., *Pisum sativum* L., *Solanum tuberosum* Bert., *Stylosanthes* sp. (Hodges & May, 1972; Bolkan *et al.*, 1981; Almeida & Bolkan, 1981; Lopes & Reifschneider, 1982; Mohanan & Sharma, 1985a; Dianese *et al.*, 1986; Dianese *et al.*, 1987).

Distribution: widely distributed including Brazil, Canada, India, Mauritius, South Africa (Peerally, 1974b; Crous *et al.*, 1993c).

Specimens: Brazil: M.G., Horto Conceicao, near Itabira, *Pinus caribaea* roots, Hodges & May, 16 Mar. 1971, **BPI** 414550, 414551 (holotype). **India:** *B. campestris* roots, Panwar & Bohra, 1972, **IMI** 168400.

Cultures: Africa: R.S.A., N. Natal, Kwambonambi, Mondi nursery, *Eucalyptus* roots, P.W. Crous, Mar. 1990, **PPRI**, 3994, 3996; R.S.A., N. Natal, Kwambonambi, Sappi nursery, *Eucalyptus* roots, P.W. Crous, Mar. 1990, **PPRI** 3997. **Canada:** *Stylosanthes* sp., S.F. Hang, **CPC** 500. **Mauritius:** *Camellia sinensis*, A. Peerally, 1970, **IMI** 167580.

Notes: *C. clavatum* is morphologically similar to *C. gracile*. The two species can, however, easily be distinguished, as *C. gracile* has longer stipes, narrowly clavate vesicles, and 1-septate conidia larger than those of *C. clavatum*. Cultures of *C. clavatum* have a yellowish aerial mycelium on MEA and PDA and are relatively slow growing when compared to other species with 1-septate conidia such as *C. scoparium*, *C. candelabrum* and *C. floridanum* and *C. gracile*.

Panwar & Bohra (1974) described *C. brassicae* from roots of *Brassica campestris* in India. The specimen of this species lodged at IMI (**IMI** 168400) is depauperate. The few conidia that were observed fell within the size range given by the authors, being 35-45 x 4-7 μm. Vesicles were clavate, and phialides doliiform. This species fits the criteria of *C. clavatum*, having smaller conidia and shorter stipes than *C. gracile*.

El-Gholl et al. (1993) recently described the heterothallic holomorph of *C. clavatum* as *Calonectria clavata* Alfieri, El-Gholl & Barnard. However, the strains used to obtain the teleomorph are reported to have larger conidial dimensions than that of the type of *Cylindrocladium clavatum*. We therefore choose to not accept the teleomorph, pending the outcome of present molecular studies on *Cylindrocladium* species with 1-septate conidia and clavate vesicles.

5. **Cylindrocladium colhounii** Peerally var. **colhounii** *Trans. Br. mycol. Soc.* **61:** 92 (1973).
Holomorph: **Calonectria colhounii** Peerally var. **colhounii**
Calonectria colhounii Peerally *Trans. Br. mycol. Soc.* **61:** 92 (1973).
Illustrations: Figs 5, 36; Peerally (1973, 1974i).
Descriptions: Peerally (1973, 1974i).

Macroconidiophores. *Stipe* septate, hyaline, terminating in a narrowly clavate vesicle, (3-)4 μm diam.; stipes (160-)210(-280) μm long. *Conidiophore branches*: primary branches non-septate to 1-septate, (12-)21(-30) x (3-)5(-7) μm; secondary branches non-septate to rarely 1-septate, (12-)16(-20) x (3-)4(-5) μm; tertiary branches non-septate, (8-)11(-14) x (3-)4 μm; quaternary branches non-septate, (7-)10(-12) x (3-)4 μm. *Phialides* elongate, doliiform to reniform, hyaline, non-septate, (7-)11(-16) x (3-)4 μm. *Conidia* cylindrical, hyaline, (1-)3-septate, rounded at both ends, (45-)59(-70) x (4-)5(-6) μm. *Microconidiophores* unknown.

Cultural characteristics. *Temperature* min. above 8 C; max. below 33 C; opt. 25 C. This is a moderate temperature species, with no sporulation on aerial mycelium. *Colony colour* (reverse) 13'I tawny (Rayner, 1970), 6D8 light brown (Kornerup & Wanscher, 1967). *Chlamydospores* extensive, in coarse chains throughout the medium, forming microsclerotia.

Teleomorph. *Perithecia* globose to subglobose, 350-500 x 320-400 μm, with warty outer wall and papillate ostiole, yellow to orange, base and lower perithecial wall turning blood-red in 3 % KOH. *Asci* hyaline, clavate, 80-180 x 15-30 μm, tapering to a long thin stalk, containing four ascospores. *Ascospores* hyaline, straight or fusiform, (1-)3-septate, slightly constricted at septa, (30-)51(-70) x (4-)5(-8) μm.

Type: Mauritius: *Camellia sinensis*, A. Peerally, 1972, **IMI** 167581.
Symptoms: leaf spot, fruit rot (Peerally, 1974i; Siddaramaiah, 1988).
Hosts: *Annona* spp., *Arachis* spp., *Heuchera americana* Georgi, *Canavalia ensiformis* (L.) DC., *Callistemon lanceolatus* (Sm.) DC., *Camellia sinensis*, *Castanea vulgaris* Lam., *Centrosema* spp., *Carya* sp., *Eucalyptus robusta* Sm., *E. grandis*, *Eucalyptus* spp., *Eugenia caryophyllus* St. Lag., *Ficus carica* L., *Pinus strobus* L., *Thea sinensis* L., *Wistaria chinensis* DC. (Peerally, 1974i; Rossman, 1983; Siddaramaiah, 1988; Hutton & Sanewski, 1989; Lenné & De Alvarez, 1990).

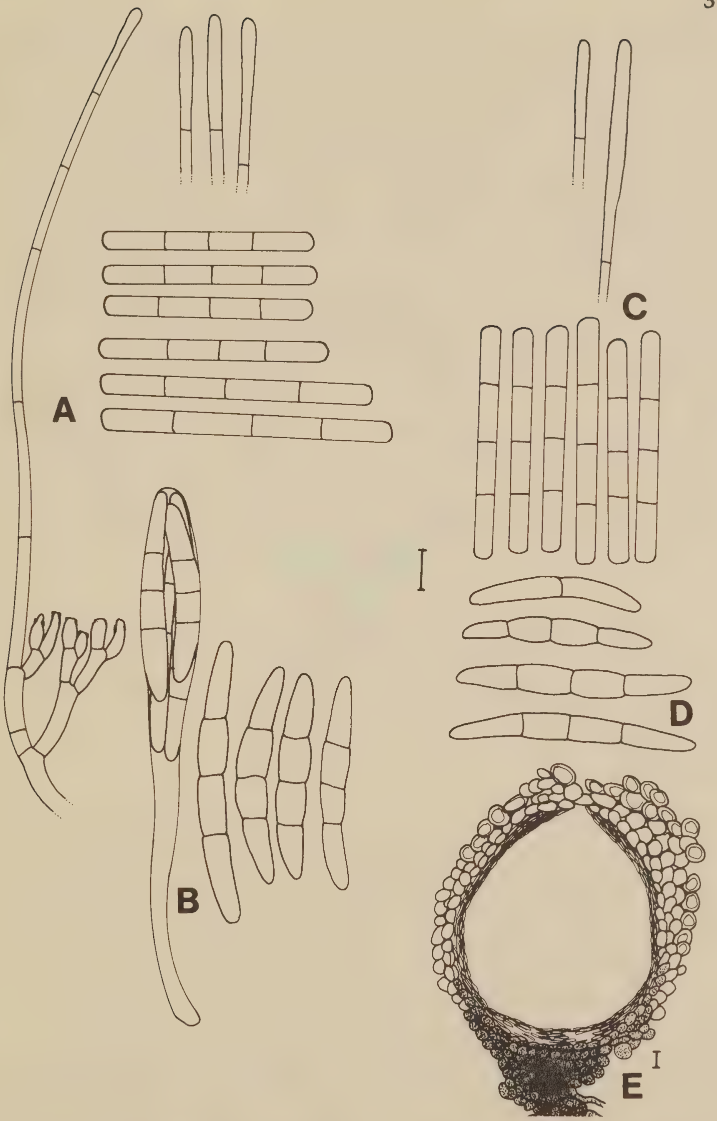


Fig. 5A-E. *Calonectria colhounii* var. *colhounii* and its *Cylindrocladium colhounii* var. *colhounii* anamorph (bar = 10 μm). A, conidiophore, clavate vesicles and conidia; B, ascus and ascospores (**PPRI** 4183); C, clavate vesicles and conidia; D, ascospores; E, v.s. of a perithecium (**IMI** 167581, type) (bar = 20 μm).

Distribution: Australia, India, Mauritius, Colombia, U.S.A. (Florida, Hawaii, Louisiana) (Peerally, 1974i; Rossman, 1983; Siddaramaiah, 1988; Lenné & De Alvarez, 1990).
Specimens: India: *Canavalia ensiformis*, 1986, **IMI** 308494. **Mauritius:** *Camellia sinensis*, M.A. Peerally, 1972, **IMI** 167581 (holotype).
Cultures: Australia: *Arachis pintoi*, D. Hutton, N8335, N8710, N9060, N9190, **PPRI** 4735-4738. **Colombia:** *Centrosema* sp., J.M. Lenné, 1990, **PPRI** 4748. **USA:** unknown hosts, A. Alfenas, (Viçosa, Brazil, **UFV** 4A, 22A, 51A, 52A, 53A, 65A), **PPRI** 4182-4187; Louisiana, *Ficus carica*, G.E. Holcomb, summer 1991, AR 2684, **PPRI** 4739; Virginia, Giles Co., Cascades Recreation site, 4 miles north of Pembroke, 37° 23 N, 80° 35 W, pericarp of *Carya* nut, G.J. Samuels, 18 Sept. 1991, GJS 91-117, **PPRI** 4740.
Notes: this species is easily recognized by its yellow perithecia which form readily in culture, and distinguish it from all other species in the genus. It is further characterized by having 3-septate conidia shorter than 70 μm, and stipes shorter than 280 μm, terminating in clavate vesicles. Only the perithecial stromata and bases turn red in 3 % KOH.

6. Cylindrocladium colhounii Peerally var. **macroconidialis** Crous, Wingfield & Alfenas *Mycotaxon* **46:** 222 (1993).
Holomorph: **Calonectria colhounii** Peerally var. **macroconidialis** Crous, Wingfield & Alfenas *Mycotaxon* **46:** 222 (1993).
Illustrations: Figs 6, 33-35.
Descriptions: Crous *et al.*, (1993d).

Morphologically similar to var. *colhounii*. *Macroconidiophores*. *Stipe* septate, hyaline, terminating in a narrowly clavate vesicle, (3-)4(-5) μm diam.; stipes (240-)280(-320) μm long. *Conidiophore branches*: primary branches non-septate to 1-septate, (20-)31(-48) x (4-)5 μm; secondary branches non-septate to rarely 1-septate, (20-)25(-30) x (4-)5 μm; tertiary and quatenary branches non-septate, (18-)20(-30) x (4-)5 μm. *Phialides* allantoid to cylindrical, hyaline, non-septate, (12-)20(-25) x (3-)4(-5) μm. *Conidia* cylindrical, hyaline, (1-)3-septate, rounded at both ends, (86-)97(-112)x (5-)7(-8) μm. *Cultural characteristics* identical to var. *colhounii*. Isolates of var. *macroconidialis* do, however, grow faster than those of var. *colhounii*, and have medium numbers of chlamydospores.

Teleomorph. *Perithecia* morphologically and anatomically identical to those of var. *colhounii*.

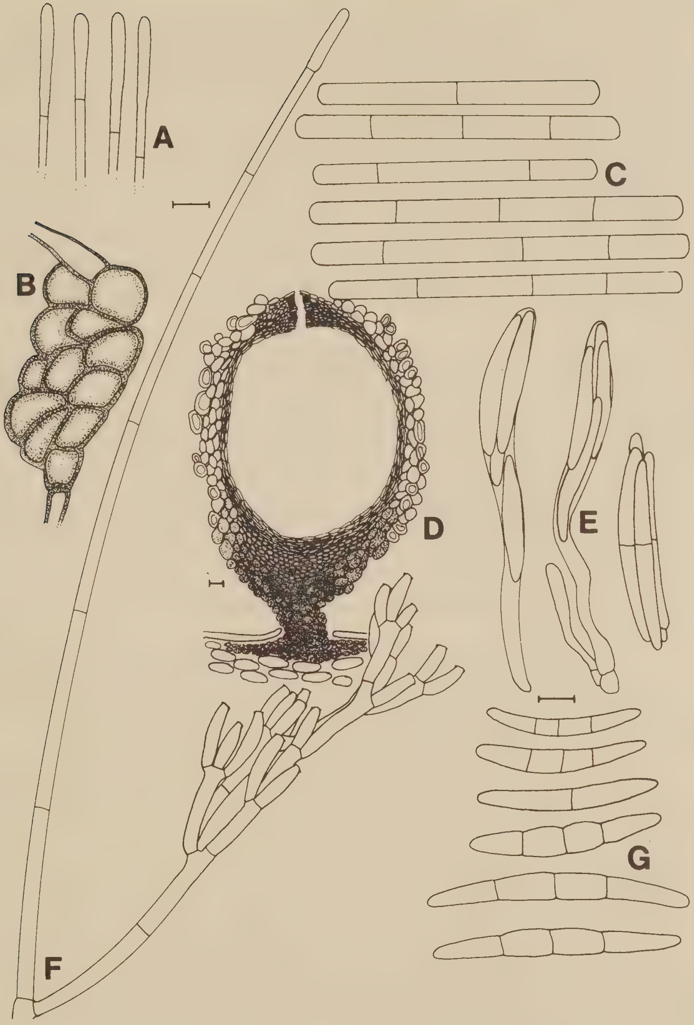


Fig. 6A-G. *Calonectria colhounii* var. *macroconidialis* and its *Cylindrocladium colhounii* var. *macroconidialis* anamorph (bar = 10 μm). A, clavate vesicles; B, microsclerotium; C, conidia; D, v.s. of a perithecium; E, asci and ascospores; F, conidiophore; G, ascospores on CLA (**PPRI** 4000) (bar = 20 μm).

Type: South Africa: E. Transvaal, Sabie, Frankfort, *Eucalyptus* cuttings, P.W. Crous, 16 Apr. 1991, **PREM** 51035, holotype of anamorph; E. Tvl., Sabie, Frankfort, *E. grandis* cuttings, P.W. Crous, March 1990, **PREM** 51036, holotype of teleomorph.
Symptoms: cutting rot, leaf spot, root rot, wilt.
Hosts: *Eucalyptus grandis*
Distribution: South Africa.
Cultures: Africa: RSA, E. Tvl., Sabie, Frankfort, *E. grandis* cuttings, P.W. Crous, March 1990, **PPRI** 4000; RSA, E. Tvl., Sabie, Frankfort, D.R. de Wet clone bank, *E. grandis* ramets (roots), P.W. Crous, 11 May 1990, **PPRI** 4001.
Notes: *C. colhounii* var. *macroconidialis* is characterized by larger conidia, longer stipes and cylindrical phialides than those of *C. colhounii* var. *colhounii*. These two varieties of *Cylindrocladium colhounii* belong to the only *Calonectria* sp. characterized by yellow perithecia and four-spored asci. Isolates of the two varieties are morphologically similar in culture, having the same temperature requirements and cultural pigmentation. However, isolates of var. *macroconidialis* grow faster than those of var. *colhounii*. Whereas all isolates obtained of var. *colhounii* were homothallic, no homothallic isolates have yet been found for var. *macroconidialis*.

C. colhounii var. *macroconidialis* causes a serious cutting rot disease of *Eucalyptus* cuttings in nurseries in the Eastern Transvaal of South Africa (Crous *et al*., 1993c).

7. **Cylindrocladium curvatum** Boedijn & Reitsma *Reinwardtia* **1:** 54 (1950).
Illustration: Fig. 7.
Descriptions: Boedijn & Reitsma (1950); Sharma *et al*. (1985).

Macroconidiophores. *Stipe* septate, hyaline, terminating in a sphaeropedunculate vesicle, 5 μm diam. *Conidiophore branches*: primary branches 25-31 x 2-4 μm; secondary branches 9-13 x 2-3 μm. *Phialides* 7-10 x 2-3 μm. *Conidia* cylindrical, hyaline, 1-septate, curved, rounded at both ends, 40-46 x 3-4 μm. *Chlamydospores* formed in original culture. *Microconidiophores* unknown; *Teleomorph* unknown.

Type: none lodged.
Symptoms: leaf spot (Boedijn & Reitsma, 1950).
Host: *Hibiscus sabdariffa* L. (Boedijn & Reitsma, 1950).
Distribution: Java, India (Boedijn & Reitsma, 1950; Sharma *et al*., 1985).

Specimens and cultures: none available.
Notes: this species is distinguished primarily by its curved conidia. Boedijn & Reitsma (1950) lost their type culture, and also did not lodge any type specimen. Sharma *et al.* (1985) reported this fungus from Kerala, India, where it caused a root rot on *Eucalyptus* spp. The conidial dimensions they reported were larger (35-60 x 3.2-5 μm) than those in the original description (40-46 x 3-4 μm). Because no material of this species has been maintained at either Kerala or IMI, the identity of the second collection from India cannot be confirmed.

8. Cylindrocladium floridanum Sobers & Seymour *Phytopathology* **57:** 392 (1967).
Holomorph: **Calonectria kyotensis** Terashita, *Trans. Mycol. Soc. Japan* **8:** 124 (1968).
Calonectria uniseptata Gerlach *Phytopath. Z.* **61:** 379 (1968).
Calonectria floridana Sobers *Phytopathology* **59:** 366 (1969).
Illustrations: Figs 8, 39, 40; Sobers & Seymour (1967); Terashita (1968); Sobers (1969).
Descriptions: Sobers & Seymour (1967); Sobers (1969).

Macroconidiophores. *Stipe* septate, hyaline, terminating in a sphaeropedunculate vesicle, (6-)10(-12) μm diam.; stipes (100-)160(-200) μm long. Lateral stipes (90° to main axis) also present. *Conidiophore branches*: primary branches non-septate or rarely 1-septate, (16-)20(-25) x (4-)5(-7) μm; secondary branches non-septate, (10-)16(-21) x (3-)4(-5) μm; tertiary branches non-septate, (10-)14(-17) x (3-)4(-5) μm; quaternary branches non-septate, (8-)12(-16) x (3-)4. *Phialides* doliiform to reniform, hyaline, non-septate, (9-)10(-13) x (3-)4(-5) μm. *Conidia* cylindrical, hyaline, 1-septate, rounded at both ends, (35-)40(-50) x (3-)4(-5) μm. *Microconidiophores* unknown.

Cultural characteristics. *Temperature* min. above 8 C; max. above 35 C; opt. 25-30 C. This is a high temperature species, with medium sporulation on aerial mycelium. *Colony colour* (reverse) 13K - 17"B amber brown to cinnamon-buff (Rayner, 1970), 6D8 - 5B5 light brown to greyish orange (Kornerup & Wanscher, 1967). *Chlamydospores* extensive, throughout medium, very dense, occasionally in chains, forming microsclerotia.

Teleomorph. *Perithecia* globose to ovoid, 280-550 x 210-425 μm, with warty outer wall and flattened ostiole, red to orange in colour,

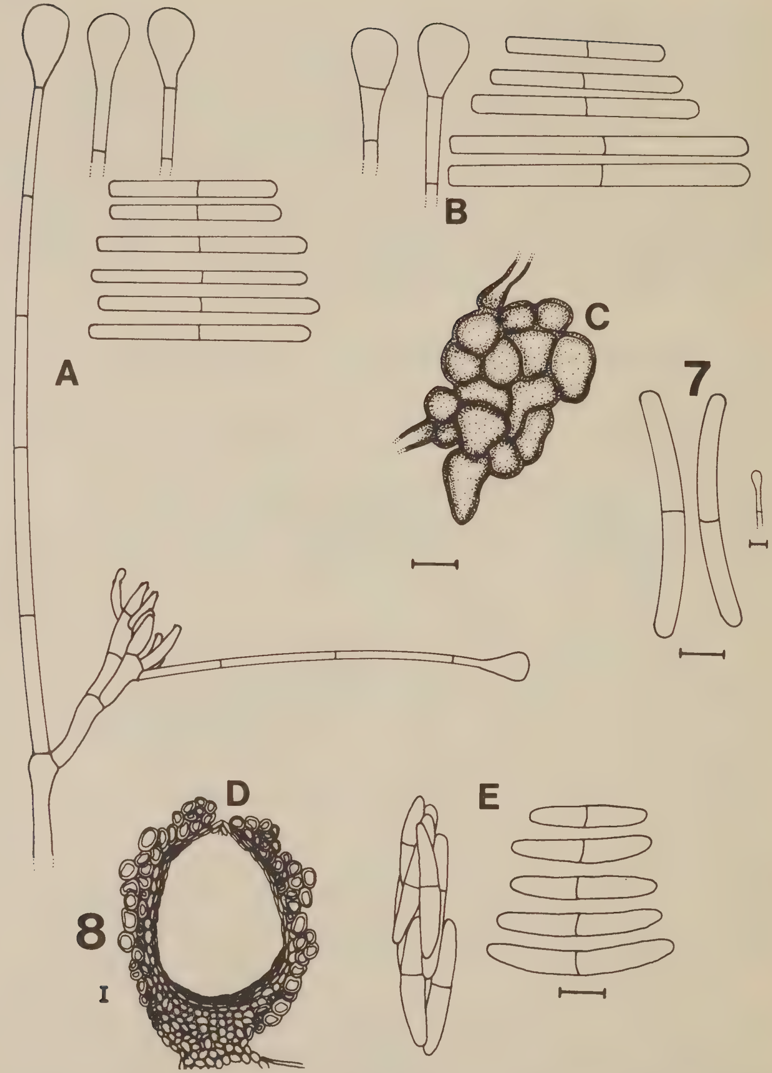


Fig. 7. Conidia and sphaeropedunculate vesicle of *Cylindrocladium curvatum* (redrawn from Boedijn & Reitsma, 1950) (bar = 10 μm). Fig. 8A-E. *Calonectria kyotensis* and its *Cylindrocladium floridanum* anamorph (bar = 10 μm). A, conidiophore with lateral branch, vesicles and conidia (**PPRI** 4140); B, sphaeropedunculate vesicles and conidia (**BPI** 414553, type of *C. floridanum*); C, microsclerotium; D, v.s. through a perithecium; E, ascospores (**PPRI** 4140) (bar = 20 μm).

turning blood-red in 3 % KOH. *Asci* hyaline, clavate, 70-140 x 13-22 μm, tapering to a long thin stalk, containing eight ascospores. *Ascospores* hyaline, straight or falcate, 1-septate, not constricted at septum, (18-)35(-48) x (4-)5(-7) μm.

Type: USA: Florida, Monticello, *Prunus* sp., E.K. Sobers, 12 Apr. 1965, **BPI** 414553 (holotype of anamorph). **Japan:** Kyoto, Momoyama, Kansai Reg. For. Exp. Sta., on leaflet of *Robinia pseudoacacia* L., Terashita, Sept. 1963, (holotype of teleomorph, not examined).
Symptoms: root rot, leaf spots, wilting and death (Sobers & Seymour, 1967; French & Menge, 1978).
Hosts: *Callistemon rigidus* R. Br., *C. citrinus* Stapf., *Crotalaria spectabilis* Roth, *Eucalyptus camaldulensis* Dehnh., *E. robusta*, *E. rudis* Endl., *E. saligna*, *E. tereticornis* Sm., *Pinus palustris* Mill. Gard. Dict., *Prunus persica* Stokes, *Rhododendron obtusum*, *R. pseudoacacia*, *Rumohra adiantiformis*, *Trifolium pratense* L. (Sobers & Seymour, 1967; Cordell *et al.*, 1971; French & Menge, 1978; Kuhlman *et al.*, 1980; Forsberg, 1985).
Distribution: Brazil, Canada, U.S.A. (Florida, Georgia), Germany, Japan, India, New Zealand, Great Britain, Malaysia, Mauritius and Sri Lanka (Sobers & Seymour, 1967; Gerlach, 1968; Terashita, 1968; Sobers, 1972; Boesewinkel, 1974; Peerally, 1974a; Sharma & Mohanan, 1982).
Specimens: India: Sabah, *Pinus caribaea*, 1979, **IMI** 240406. **USA:** Florida, Monticello, *Prunus* sp., E.K. Sobers, 12 Apr. 1965., **BPI** 414553 (holotype); *Prunus* tree roots, R.H. Morrison, **BPI** 414554, 414555.
Cultures: Canada: *Pinus* seedlings, M. Dumas, **UFV** 75, **CPC** 509; Ontario, conifer roots, J. Juzwik, Oct. 1984, AR 2573, 2574, **CPC** 510, 511; Ontario, spruce seedling roots, S. Greifenhagen, 1992, **CPC** 512, 513. **USA:** Florida, *Rumohra adiantiformis*, S.A. Alfieri, **ATCC** 42971; *R. adiantiformis*, El-Gholl, P88-5641, **CPC** 514; *Pinus palustris*, El-Gholl, P85-2179, **CPC** 515; Florida, *Prunus persica*, N.E. El-Gholl, (Viçosa, Brasil, **UFV** 7), **PPRI** 4140; Unknown hosts, A. Alfenas, (Viçosa Brazil, **UFV** 31, 33, 35), **PPRI** 4167, 4169, 4171; Florida, *Trifolium pratense*, N.E. El-Gholl, (Viçosa, Brazil, **UFV** 32) **PPRI** 4168; Georgia, peach tree roots, D.J. Weaver, AR 2600, **ATCC** 22677.
Notes: *C. floridanum* is frequently confused with *C. scoparium*. Boesewinkel (1986) reports, however, that they can be distinguished by the shape of their microsclerotia and amount of pigmented mycelium. Although these differences have been observed in some cultures, they do not hold true for all isolates of *C. floridanum*. In this study, vesicle morphology in *C. floridanum* was found to be a sufficiently stable characteristic on which to separate this species from *C. scoparium*.

Vesicles of *C. floridanum* are always sphaeropedunculate, whereas those of *C. scoparium* are obovoid with a papillate apex, and those of *C. candelabrum* are obpyriform (Figs 2, 7, 19).

Branches that form on the stipe of *C. floridanum* are frequently produced at 90° to the main axis (Sobers & Seymour, 1967). Although branching of the stipe in *C. scoparium* and *C. candelabrum* is common, it never occurs at this angle.

9. **Cylindrocladium gracile** (Bugn.) Boesewinkel *Trans. Br. mycol. Soc.* **78:** 554 (1982).
Cylindrocarpon gracile Bugnicourt *Encycl. Mycol.* **11:** 162 (1939).
Holomorph: **Calonectria gracilis** Crous, Wingfield & Alfenas *Mycotaxon* **46:** 224 (1993).
Illustrations: Figs 9, 41-43; Bugnicourt (1939); Booth (1966).
Descriptions: Bugnicourt (1939); Booth (1966); Crous *et al.* (1993d).

Macroconidiophores. *Stipe* septate, hyaline, terminating in a narrowly clavate vesicle, (2-)4(-5) μm diam.; stipes (160-)220(-350) μm long. *Conidiophore branches*: primary branches non-septate or rarely 1-septate, (14-)18(-25) x (3-)4(-5) μm; secondary branches non-septate, (12-)15(-16) x (3-)4(-5) μm. *Phialides* doliiform to reniform, hyaline, non-septate, (10-)13(-15) x (3-)4(-5) μm. *Conidia* cylindrical, hyaline, 1-septate, rounded at both ends, (40-)56(-65) x (4-)5 μm. *Microconidiophores* unknown.

Cultural characteristics. *Temperature* min. above 10 C; max. above 35 C; opt. 30 C. This is a high temperature species, with medium sporulation on aerial mycelium. *Colony colour* (reverse) 13K - 17"K amber brown to Saccardo's umber (Rayner, 1970), 6D8 - 5E7 light brown to linoleum brown (Kornerup & Wanscher, 1967). *Chlamydospores* extensive, dense, throughout medium, forming microsclerotia.

Teleomorph. Perithecia superficial, borne singly or in small groups, 350-400 x 330-380 μm, with warty outer wall and papillate ostiole, red to red-brown, turning blood-red in 3 % KOH. *Asci* hyaline, clavate, (75-) 90 (-100) x (8-) 10 (-15) μm, tapering to a long thin stalk, containing 8 ascospores. *Ascospores* hyaline, straight or falcate, guttulate, 1-septate, not constricted at median septum, (27-)37(-50) x (4-)5(-6) μm.

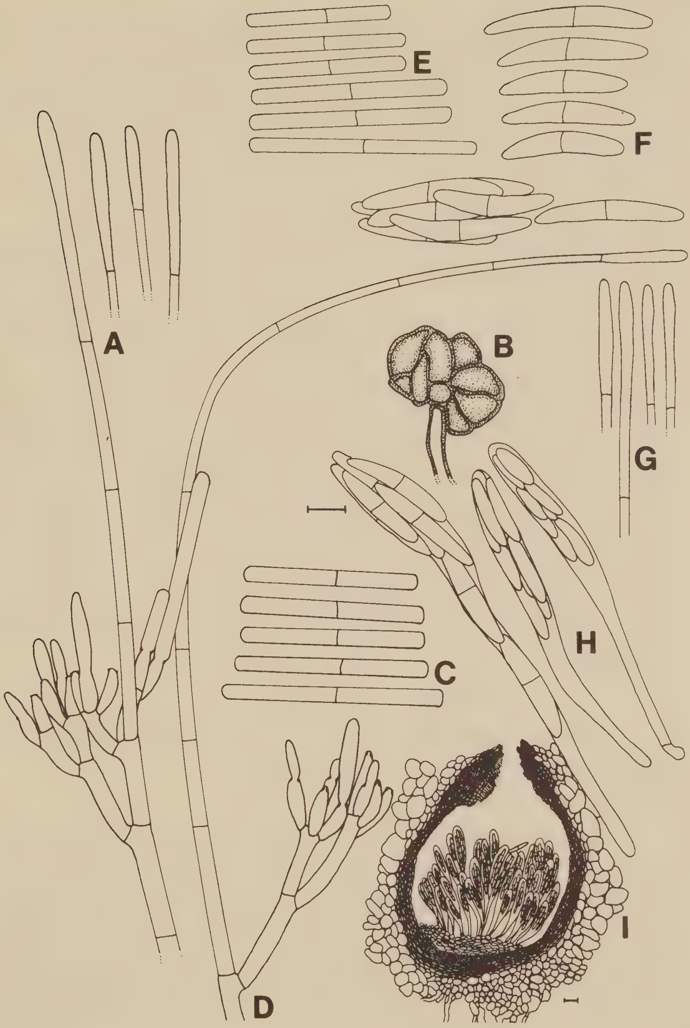


Fig. 9A-I. *Calonectria gracilis* and its anamorph *Cylindrocladium gracile* (bar = 10 μm). A, conidiophore and clavate vesicles; B, microsclerotium; C, conidia on CLA (**PC** 551197, type); D, conidiophore (**PREM** 51031, type of teleomorph); E, conidia; F, ascospores; G, clavate vesicles; H, asci; I, v.s. of a perithecium (bar = 20 μm).

Type: South East Asia (Vietnam): *Argyreia splendens* Sweet, 1937, Bugnicourt, derived from Paris (PC) No. 551197, **IMI** 117577, **PREM** 51032 (holotype, anamorph). **Brazil:** Para, near Belem, *Manilkara zapota* (L.) van Royen, 1990, F. Carneiro de Albuquerque, **PREM** 51031 (holotype teleomorph).
Symptom: root rot.
Hosts: *Manilkara zapota*, *Argyreia splendens*, *Pahudia cochinchinensis* Pierre, (Bugnicourt, 1939).
Distribution: Brazil, Canada, South East Asia (Indo China) (Bugnicourt, 1939).
Cultures: South East Asia (Vietnam): Herb. Paris (**PC**) No. 551197 (type culture). **Brazil:** PA, Belem, *Manilkara zapota* (L.) van Royen, F. Albuquerque, **PPRI** 4176, **IMI** 354519.
Notes: Among the 1-septate *Cylindrocladium* spp., *C. gracile* has a similar vesicle morphology to that of *C. clavatum*. An authenticated culture (Paris 551197) of this fungus was examined, and this species was distinct from *C. clavatum* in having longer stipes and larger conidia. There have also been recent reports of *C. gracile* from Canada (Chang & Blenis, 1987), and Brazil (Crous *et al.*, 1993d). Ascospores of the teleomorph are fusoid, 1-septate, and similar in size to those of *C. kyotensis* and *C. morganii*, but smaller than those of *C. scoparia* and *C. avesiculata*.

10. **Cylindrocladium hawksworthii** Peerally *Mycotaxon* **40:** 375 (1991).

Illustrations: Figs 10, 44; Peerally (1991b).
Description: Peerally (1991b).

Macroconidiophores. *Stipe* septate, hyaline, terminating in a ellipsoidal to pyriform or clavate vesicle, (6-)7(-9) μm diam.; stipes (150-)200(-250) μm long. *Conidiophore branches*: primary branches non-septate or rarely 1-septate, (18-)30(-45) x (4-)5 μm; secondary branches non-septate, (13-)17(-25) x (4-)5 μm; tertiary and quatenary branches non-septate, (10-)12(-15) x 4(-5) μm. *Phialides* doliiform to reniform, hyaline, non-septate, (10-)14(-16) x 4(-5) μm long. *Conidia* cylindrical, hyaline, curved, 1-septate, rounded at both ends, (42-)56(-76) x 4(-5) μm. *Microconidiophores* unknown; *Teleomorph* unknown.

Cultural characteristics. *Temperature* min above 5 C; max. below 35 C; opt. 30 C. This is a eurythermal species, with moderate sporulation on aerial mycelium. *Colony colour* (reverse) 13"K verona brown (Rayner, 1970), 5E7 linoleum brown (Kornerup & Wanscher, 1967).

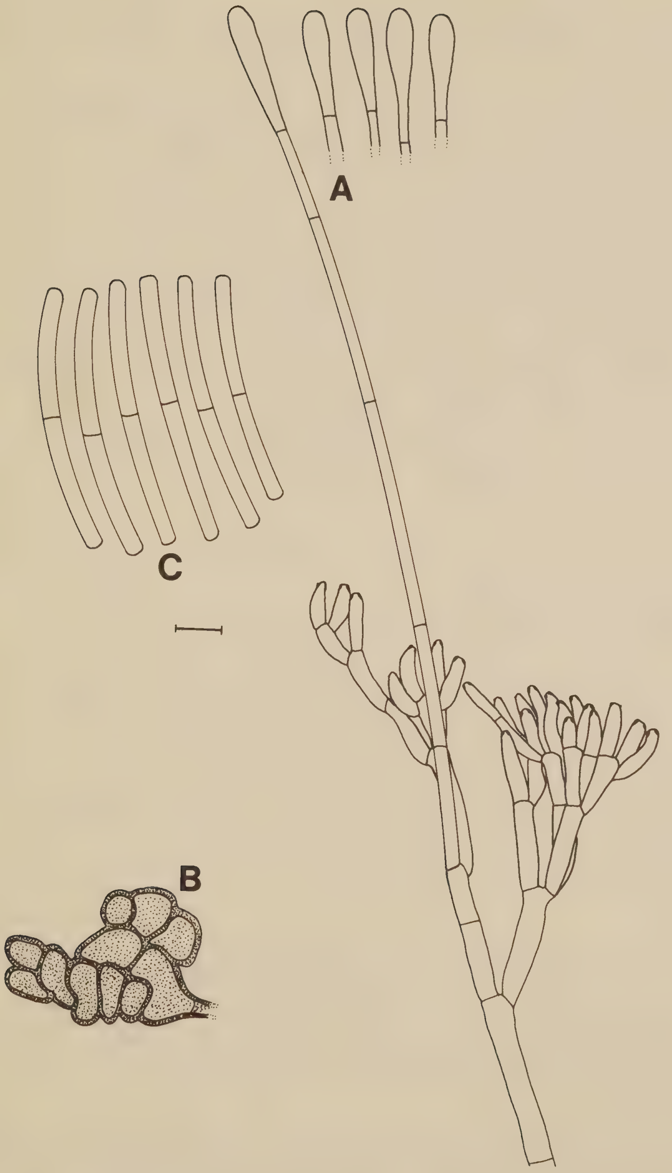


Fig. 10A-C. *Cylindrocladium hawksworthii* (bar = 10 μm). A, conidiophore and clavate to ellipsoidal vesicles; B, microsclerotium; C, conidia on CLA (**MUCL** 30866, type).

Chlamydospores extensive, dense, dispersed throughout medium, forming microsclerotia.

Type: Mauritius: Pamplemousses garden, leaves of *Nelumbo nucifera* Gaertn-Fuct., A. Peerally, 1990, **MUCL** 30866 (holotype).
Symptoms: leaf spots (Peerally, 1991b).
Hosts: *Nelumbo nucifera*, *Nymphaea lotus* L. (Peerally, 1991b).
Distribution: Mauritius (Peerally, 1991b).
Specimens: Mauritius: Pamplemousses garden, leaves of *Nelumbo nucifera*, A. Peerally, 1990, **MUCL** 30866 (holotype); Pamplemousses garden, *Nymphaea lotus*, A. Peerally, 1990, **MUCL** 30865 (paratype).
Culture: Mauritius: Pamplemousses garden, leaves of *Nelumbo nucifera*, A. Peerally, 1990, **MUCL** 30866 (*ex* holotype).
Notes: this species is morphologically very similar to *C. scoparium*, but has curved conidia. It is distinguished from *C. curvatum* by its larger conidia, and ellipsoidal vesicles.

11. **Cylindrocladium heptaseptatum** Sobers, Alfieri & Knauss

Phytopathology **65:** 333 (1975).
Illustrations: Fig. 11; Sobers *et al.* (1975); El-Gholl *et al.* (1987).
Descriptions: Sobers *et al.* (1975); El-Gholl *et al.* (1987).

Macroconidiophores. *Stipe* septate, hyaline, terminating in a narrowly clavate vesicle, (3-)4(-5) μm diam.; stipes (320-)420(-550) μm long. *Conidiophore branches*: primary branches non-septate, (16-)22(-30) x (4-)5 μm; secondary branches non-septate, (14-)17(-25) x (4-)5 μm. *Phialides* cylindrical to allantoid, hyaline, non-septate, (14-)17(-20) x (3-)4(-5) μm. *Conidia* cylindrical, hyaline, (1-)7(-8)-septate, rounded at both ends, (96-)118(-144) x (6-)8(-9) μm.

Cultural characteristics. *Temperature* min. above 10 C; max. below 33 C; opt. 25 C. This is a moderate temperature species, with medium sporulation on aerial mycelium. *Colony colour* (reverse) 13K amber brown (Rayner, 1970), 6D8 light brown (Kornerup & Wanscher, 1967). *Chlamydospores* extensive, arranged as coarse chains, forming microsclerotia.

Microconidiophores. *Stipe* septate, hyaline, terminating in a clavate vesicle when present. *Conidiophore branches*: primary branches non-septate, (11-)19(-29) x (2-)3(-5) μm; secondary branches non-septate, (9-)14(-20) x (2-)3(-4) μm. *Phialides* arise from the

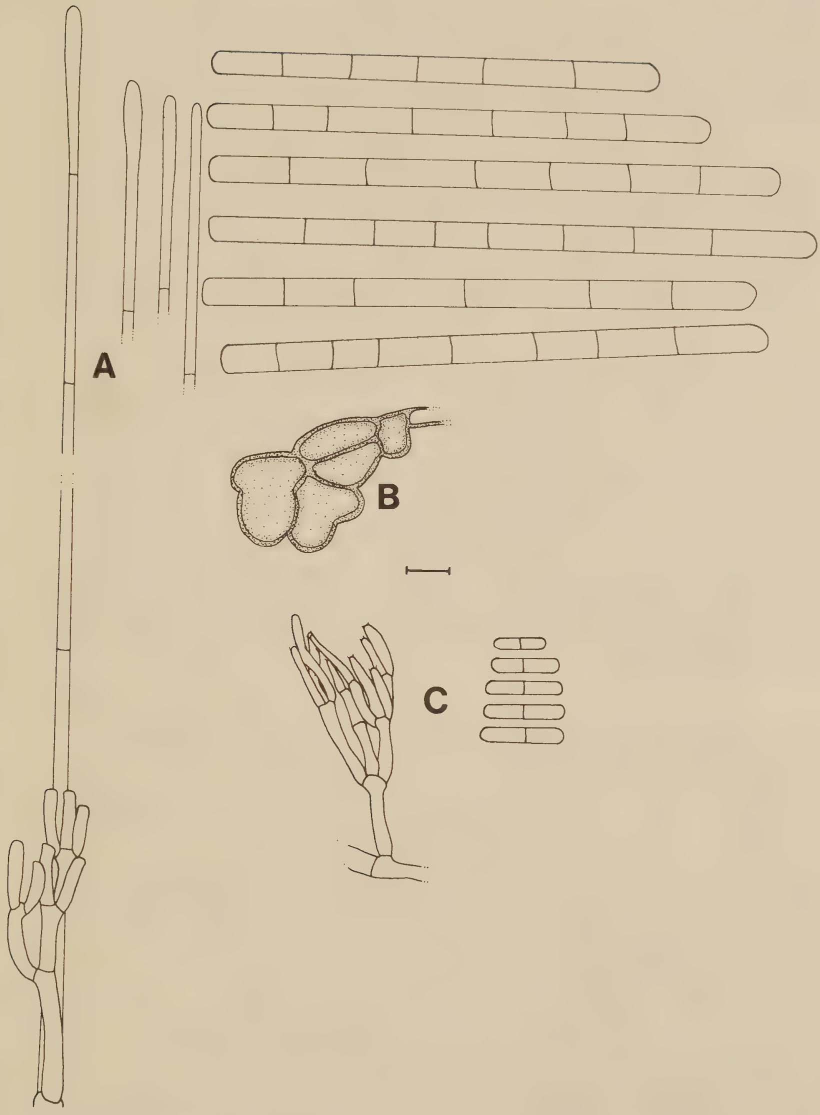


Fig. 11A-C. *Cylindrocladium heptaseptatum* (bar = 10 μm). A, macroconidiophore, clavate vesicles and conidia; B, microsclerotium on CLA (ATCC 42972); C, microconidiophore and conidia on CLA (FTCC 1003).

ends of branches, in groups of 2-4, cylindrical, hyaline, non-septate, (7-)14(-17) x (2-)3(-4) µm, collarettes present. *Conidia* cylindrical, hyaline, 1-septate with obtuse ends, (12-)16(-22) x (2-)3(-4) µm. *Teleomorph* unknown.

Type: Brazil: Honduras, *Polystichum adiantiforme*, **(NY)**, **ATCC** 38228.
Symptoms: leaf spots and stem lesions (Sobers *et al.*, 1975).
Hosts: *Polystichum adiantiforme* (Forst.) J.E. Sm., *Rumohra adiantiformis* (Forst.) Ching, (Sobers *et al.*, 1975; Marousky & Wildt, 1982).
Distribution: Honduras, Florida, U.S.A. (Florida), Thailand (Sobers *et al.*, 1975; Chase, 1984).
Cultures: USA: Florida, *Rumohra adiantiformis*, S.A. Alfieri, **ATCC** 42972; Florida, *R. adiantiformis*, N.E. El-Gholl, **FTCC** 1002 (macroconidial isolate), **FTCC** 1003 (microconidial isolate). Thailand: *Eucalyptus* sp., M.J. Wingfield, 3 Aug. 1992, **CPC** 516.
Notes: *C. heptaseptatum* has large multi-septate conidia and clavate vesicles. Other *Cylindrocladium* spp. with multi-septate conidia and clavate vesicles are *C. colhounii* var. *colhounii* & var. *macroconidialis*, *C. theae* and *C. quinqueseptatum*. *C. heptaseptatum* is distinguished from these species by having 7-septate conidia. The other species mentioned above all have 3-septate conidia, except *C. quinqueseptatum*, which has 5-septate conidia.

12. Cylindrocladium ilicicola (Hawley) Boedijn & Reitsma *Reinwardtia* **1:** 57 (1950).
Candelospora ilicicola Hawley *apud* Rea & Hawley *Proc. R. Irish Acad.* **31:** 11 (1912).
Tetracytum laurii Vanderwalle *Parasitica* **1:** 145 (1945).
Holomorph: **Calonectria pyrochroa** (Desm.) Sacc. *Michelia* **1:** 308 (1878).
Nectria pyrochroa Desm. *Pl. Crypt. France* ed. **2:** 372 (1856). Later, *Bull. Soc. Bot. Fr.* **4:** 998 (1857).
Calonectria daldiniana De Not. *Comment. Soc. Crittogam. Ital.* **2:** 477 (1867).
Ophionectria puiggarii Speg. *Bol. Acad. Nac. Ci.* **11:** 532 (1889).
Nectria abnormis P. Hennings *Hedwigia* **36:** 219 (1897).
Illustrations: Figs 12, 45-48; Peerally (1974e); Rossman (1979).
Descriptions: Peerally (1974e); Rossman (1979); Crous *et al.* (1993e).

Macroconidiophores. *Stipe* septate, hyaline, terminating in a clavate to spathulate vesicle, (6-)8(-11) µm diam.; stipes (130-)175(-230) µm long. *Conidiophore branches*: primary branches non-septate or rarely

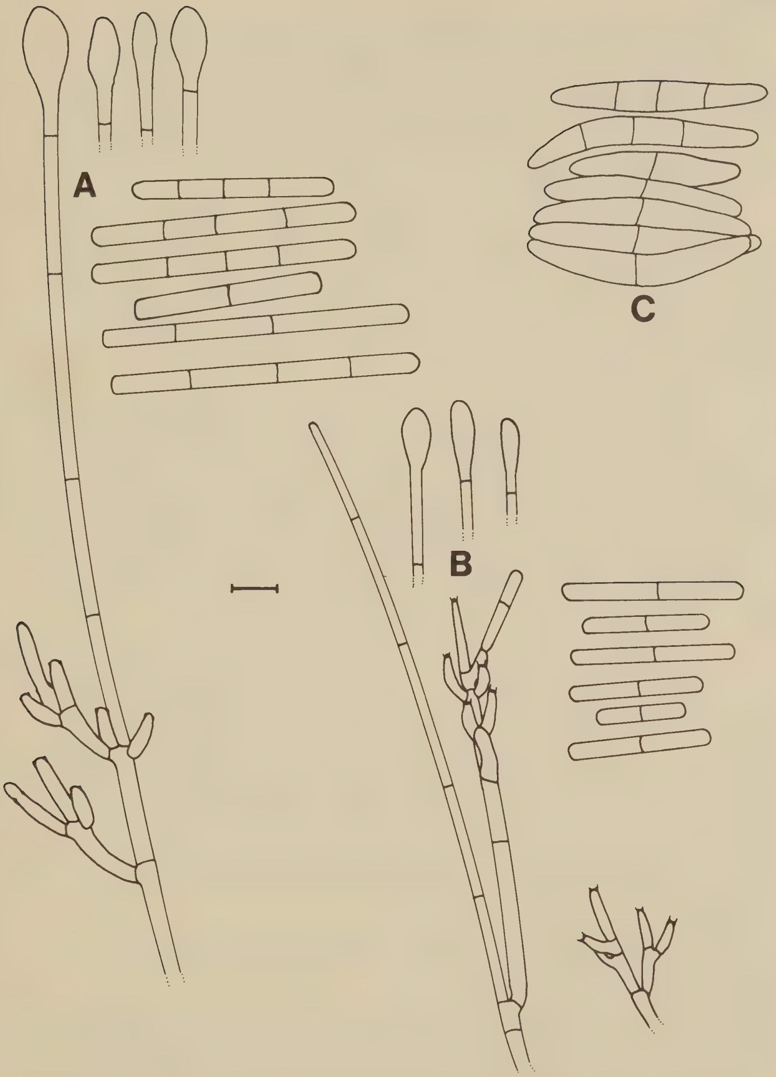


Fig. 12A-C. *Calonectria pyrochroa* and its *Cylindrocladium ilicicola* anamorph (bar = 10 μm). A, macroconidiophore, clavate to spathulate vesicles and conidia; B, microconidiophores, clavate to spathulate vesicles and conidia (**PPRI** 4151); C, ascospores, (**PC**, *C. pyrochroa*, type).

1-septate, (15-)18(-25) x (3-)4(-5) µm; secondary branches non-septate, (11-)16(-20) x (3-)4(-5) µm; tertiary branches rare, non-septate, (8-)12(-14) x (3-)4(-5) µm. *Phialides* elongate, doliiform to reniform, hyaline, non-septate, (10-)12(-15) x (3-)4(-5) µm. *Conidia* cylindrical, hyaline, (1-)3-septate, rounded at both ends, (37-)53(-70) x (3-)5 µm.

Cultural characteristics. *Temperature* min. above 8 C; max. below 35 C; opt. 25 C. This is a high temperature species, with medium sporulation on aerial mycelium. *Colony colour* (reverse) 13K amber brown (Rayner, 1970), 6D8 light brown (Kornerup & Wanscher, 1967). *Chlamydospores* extensive, arranged in fine chains forming microsclerotia throughout substratum.

Microconidiophores. *Stipe* septate, hyaline, terminating in a clavate to spathulate vesicle when present. *Conidiophore branches*: primary branches non-septate, (10-)14(-15) x 3(-4) µm; secondary branches non-septate, (9-)10(-12) x (2-)3(-4) µm. *Phialides* arise from the ends of branches, singly, or in groups of 2-4, cylindrical, hyaline, non-septate, (9-)12(-15) x (2-)3 µm, collarettes present. *Conidia* cylindrical, hyaline, 1-septate with obtuse ends, (14-)24(-31) x (3-)4 µm.

Teleomorph. *Perithecia* globose to ovoid, 400-500 x 320-370 µm, with warty outer wall and papillate ostiole, orange to red, turning blood-red in 3 % KOH. *Asci* hyaline, clavate, 90-130 x 9-18 µm, tapering to a long thin stalk, containing eight ascospores. *Ascospores* hyaline, straight or falcate, 1(-3)-septate, not or slightly constricted at septa, (28-)45(-66) x (4-)6(-7) µm.

Type: Ireland: Clare Island, *Ilex aquifolium* L., Hawley, **IMI** 76542 (holotype of anamorph); France: (**PC**), No. 372, leaves of *Platanus* sp. (lectotype of teleomorph).
Symptoms: damping-off, leaf and shoot blight, stem canker, die-back (Sharma & Mohanan, 1982).
Hosts: wide host range, including *Arbutus andrachnoides* Link, *Aesculus hippocastanum* L., *Betula* sp., *Buxus* sp., *Didymopanax morototoni* Dechne. & Planch., *E. alba* Reinw. : Bl., *E. robusta*, *E. tereticornis*, *E. grandis*, *E. globulus* Labill., *Gaultheria shallon* Pursh., *Ilex aquifolium*, *Magnolia grandiflora*, *Salix* sp., *Laurus nobilis* L., *Theobroma grandiflorum* K. Schum. (Rea & Hawley, 1912; Boedijn & Reitsma, 1950; Figueiredo & Cruz, 1963; Alfieri *et al*., 1982; Sharma & Mohanan, 1982; Brayford & Chapman, 1987).

Distribution: Scilly Is., Brazil, Ireland, Europe (France, Switzerland), India, U.S.A. (Florida) (Boedijn & Reitsma, 1950; Figueiredo & Cruz, 1963; Peerally, 1974e; Reddy, 1974; Alfieri *et al.*, 1982; Sharma & Mohanan, 1982; Brayford & Chapman, 1987).
Specimens: Brazil: Sao Paulo, leguminous plant, Ule 2282, Feb.(?) 1896, (*Nectria leguminum*, holotype), (**S**); leaves of *Lauraceae*, Puiggarii 2562, March 1888, (*ex* type *Ophionectria puiggarii*), (**FH**); A. Möller, No. 52c, *ex* sheet 5350, (isotype, *Nectria abnormis*), (**FH**). **France:** (**PC**), leaves of *Platanus* sp., (type *Nectria pyrochroa*). **Ireland:** Clare Island, *Ilex aquifolium*, Hawley, **IMI** 76542 (type *C. ilicicola*). **Switzerland:** leaves of *M. grandiflora*, Daldini, (**RO**) (*Calonectria daldiniana*, holotype, not examined).
Cultures: Brazil: Bahia, *Eucalyptus* sp., (Viçosa, Brazil No. **UFV** 28), **PPRI** 4151, **IMI** 354525 (producing microconidial state).
Notes: *C. ilicicola* has a similar vesicle morphology to that of *C. spathulatum* and *C. citri*. The last two are, however, low temperature species, while *C. ilicicola* is a high temperature species.

Rossman (1983) synonymized several early *Calonectria* collections under *C. pyrochroa*. Although that name is accepted for the holomorph *Cylindrocladium ilicicola*, not all the synonyms as listed by Rossman (1983) are recognised here. *C. daldiniana*, *Ophionectria puiggarii* and *Nectria abnormis* are accepted as synonyms of *C. pyrochroa* from the morphology of their perithecia, asci and ascospores. However, *C. indusiata* Seaver includes the teleomorph of *Cylindrocladium theae*, while *Nectria leguminum* Rehm is accepted as representative of a new species (see section on doubtful and excluded species). In an *in vitro* evaluation of 22 fungicides against *C. quinqueseptatum*, *C. floridanum* and *C. ilicicola*, the last proved to be more tolerant than the other species, only a few fungicides being effective (Sharma & Mohanan, 1991a).

13. Cylindrocladium naviculatum Crous & Wingfield *Mycotaxon* **48**: 443-444 (1994).
Illustrations: Figs 13, 57; Crous *et al.* (1994).
Descriptions: Crous *et al.* (1994).

Macroconidiophores. *Stipe* septate, hyaline, terminating in a naviculate vesicle, (6-)8(-11) μm diam; stipes (150-)180(-200) μm long. *Conidiophore branches*: primary branches non-septate or rarely 1-septate, (12-)19(-25) x (4-)5(-6) μm; secondary branches non-septate, (10-)12(-15) x (4-)5(-6) μm; tertiary branches non-septate, (10-)12(-15) x (4-)5(-6) μm; quaternary branches non-

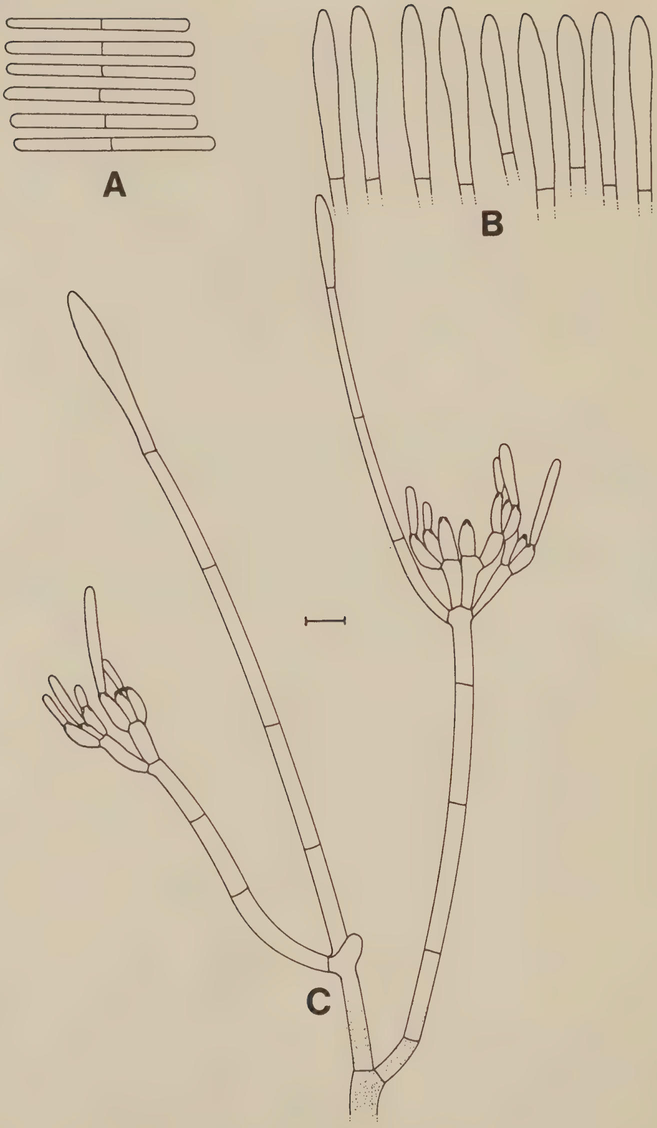


Fig. 13A-C. *Cylindrocladium naviculatum* (bar = 10 μm). A, conidia; B, naviculate vesicles; C, conidiophore (**CPC** 627).

septate, (10-)11(-14) x 4(-5) μm. *Phialides* arise from the ends of branches, in groups of 2-4, doliiform to reniform, hyaline, (9-)12(-15) x (3-)4 μm. *Conidia* cylindrical, hyaline, 1-septate rounded at both ends, (40-)43(-55) x (3-)4 μm. *Microconidiophores* unknown. *Teleomorph* unknown.

Cultural characteristics. *Temperature* min. above 5 C; max. above 35 C; opt. 25 C. This is a eurythermal species, with medium sporulation on the aerial mycelium. *Colony colour* (reverse) 13'I tawney (Rayner, 1970), 6D8 light brown (Kornerup & Wanscher, 1967). *Chlamydospores* in moderate numbers, forming fine chains with sparse microsclerotia.

Type: Brazil: Amazonia state, Manaus, soil, M.J. Wingfield, Apr. 1993, PREM 51542.
Symptoms: no disease symptoms are known, as this isolate was obtained from soil (Crous *et al.*, 1994).
Hosts: unknown, isolated from soil (Crous *et al.*, 1994).
Distribution: Brazil, Amazonia (Crous *et al.*, 1994).
Cultures: Brazil: Amazonia state, Manaus, soil, M.J. Wingfield, Apr. 1993, **CPC** 627 (culture of type); other collections from the same location, **CPC** 628, 629.
Notes: *C. naviculatum* can be distinguished from other 1-septate species of *Cylindrocladium* by the characteristic apical taper of its vesicles, the narrower conidia, moderate chlamydospore and slight microsclerotium formation. Other criteria characteristic of this species are the frequent multiple-stipes occurring in a conidiophore, as well as the very wide stipe diameter below the vesicle (Crous *et al.*, 1994).

14. **Cylindrocladium ovatum** El-Gholl, Alfenas, Crous & Schubert

Can. J. Bot. **71**: 469-470 (1993).
Illustrations: Fig. 14, 58; El-Gholl *et al.* (1993).
Descriptions: El-Gholl *et al.* (1993).

Macroconidiophores. *Stipe* septate, hyaline, terminating in an ellipsoid to ovoid vesicle, (8)10(-14) μm diam.; stipes (185-)205(-230) μm long. *Conidiophore branches*: primary branches non-septate or rarely 1-septate, (15-)26(-40) x (3-)5 μm; secondary branches non-septate, (10-)20(-29) x (3-)5 μm; tertiary branches non-septate, (10-)18(-24) x (3-)5 μm. *Phialides* arise from the ends of branches, in groups of 2, 3 or 4, doliiform to reniform, hyaline, (7-)15(-29) x (3-)5 μm. *Conidia* cylindrical, hyaline, 1(-3) septate, rounded at both ends,

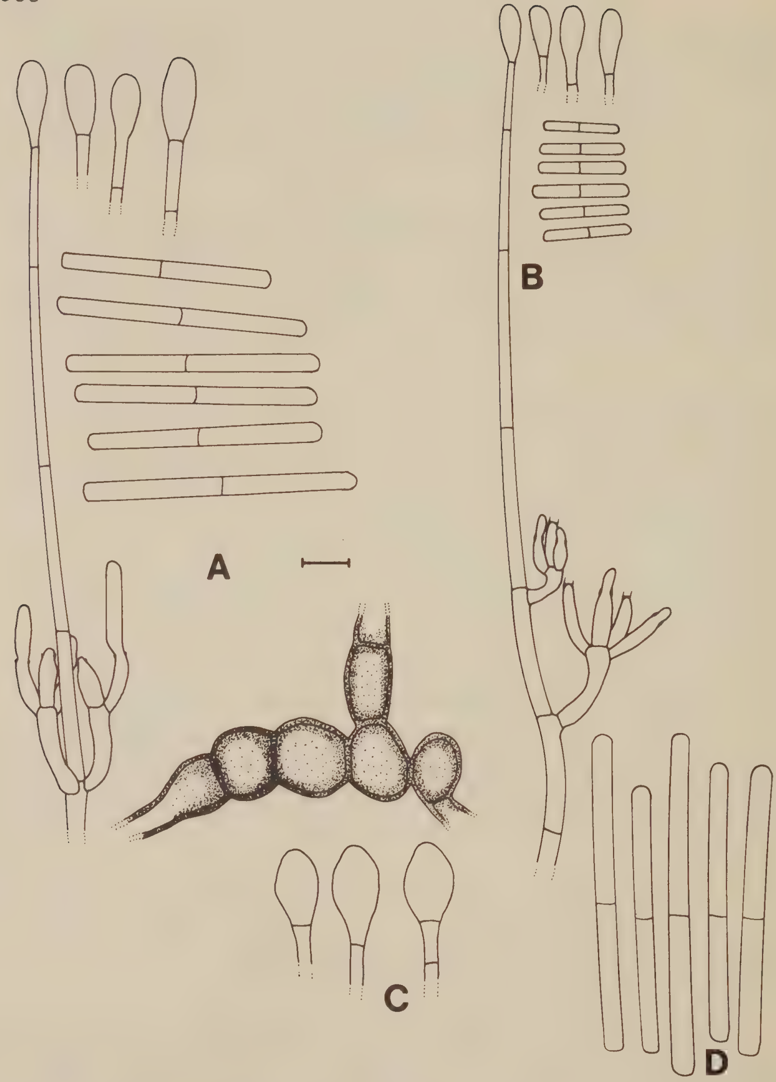


Fig. 14A-D. *Cylindrocladium ovatum* (bar = 10 µm). A, macroconidiophore, ovoid vesicles, conidia and chlamydospores; B, microconidiophore, ovoid vesicles and conidia (**PPRI** 4162); C, ovoid macrovesicles; D, conidia (**PPRI** 4147).

straight or slightly curved, (36-)65(-80) x (4-)5(-6) μm. *Teleomorph* unknown.

Cultural characteristics. *Temperature* min. above 10 C; max. above 35 C; opt. 25 C. This is a high temperature species, with medium sporulation on aerial mycelium. *Colony colour* (reverse) 13K amber brown (Rayner, 1970), 6D8 light brown (Kornerup & Wanscher, 1967). *Chlamydospores* extensive, dense, forming microsclerotia throughout substratum.

Microconidiophores. *Stipe* septate, hyaline, terminating in an ellipsoid to ovoid vesicle when present. *Conidiophore branches*: primary branches non-septate or rarely 1-septate (9-)20(-30) x (2-)4 μm; secondary branches non-septate, (8-)10(-12) x (2-)4 μm. *Phialides* arise from the ends of branches, in groups of 2-4, allantoid to navicular or doliiform, hyaline, with collarettes, (8-)15(-18) x (2-)3(-4) μm. *Conidia* cylindrical, hyaline, 1-septate with obtuse ends, (11-)21(-28) x (2-)3(-4) μm.

Type: Brazil: Para, Monte Dourado, *Eucalyptus urophylla*, N.E. El-Gholl, Mar. 1990, FLAS F55638 (holotype).
Symptoms: leaf spots, blight and root rot (Blum *et al*., 1992; El-Gholl *et al*., 1993).
Hosts: *Eucalyptus* spp.
Distribution: Brazil, Amazonia (Blum *et al*., 1992; El-Gholl *et al*., 1993).
Cultures: Brazil: Pará, Monte Dourado, *E. urophylla*, N.E. El-Gholl, Mar. 1990, **UFV** 89, **ATCC** 76225, **IMI** 354515 (type), other single-conidial isolates from this collection **UFV** 90, 91; ?, *Eucalyptus*, J. Dianese, **UFV** 24, **PPRI** 4147 and **UFV** 55, **PPRI** 4162; Amazonia, *Eucalyptus*, J. Dianese, UnB 1026; UnB 1028, **IMI** 354516.
Notes: Conidia of *C. ovatum* are nearly always 1-septate. Vesicles are ovoid or ellipsoidal (widest in the middle), intermediate between those of *C. candelabrum* Viegas which are obpyriform (widest below the middle), and *C. scoparium* Morgan which are pyriform (widest above the middle). It is probable that this species is heterothallic, as is the case for *C. scoparium* and *C. candelabrum*. However, all available isolates of *C. ovatum* were paired, but only protoperithecia observed, indicating that the correct strains have not yet been collected to produce a teleomorph. As expected, pairings with mating types of *C. scoparium* and *C. candelabrum* were also unsuccessful. Not all isolates have the ability to form the microconidial state, and the majority can produce only

1-septate conidia (not curved as some in holotype), and generally do not have septate vesicles as illustrated in the original description.

A recent study in Brazil (Blum *et al.*, 1992) compared the damping-off ability of *C. clavatum* and *C. ovatum* (UnB-1026). Results showed that certain *Eucalyptus* provenances were more disease tolerant than others, and that *C. clavatum* has a wider host range and is more aggressive towards *Eucalyptus* spp. than *C. ovatum*.

15. **Cylindrocladium parasiticum** Crous, Wingf. & Alfenas *Mycol. Res.* **97:** 892 (1993).
Cylindrocladium crotalariae (Loos) Bell & Sobers *Phytopathology* **56:** 1364 (*nom. nud.*) (1966).
Candelospora theae (Petch) Wakefield: Gadd var. *crotalariae* Loos *Trans. Br. mycol. Soc.* **33:** 17 (*nom. nud.*) (1950).
Holomorph: **Calonectria ilicicola** Boedijn & Reitsma *Reinwardtia* **1:** 58 (1950).
Calonectria theae Loos var. *crotalariae* Loos *Trans. Br. mycol. Soc.* **33:** 18 (1950).
Calonectria crotalariae (Loos) Bell & Sobers *Phytopathology* **56:** 1364 (1966).
Illustrations: Figs 15, 37, 38; Bell & Sobers (1966); Peerally (1974h).
Descriptions: Bell & Sobers (1966); Sobers & Alfieri (1972); Nishijima & Aragaki (1973); Peerally (1974h); Crous *et al.* (1993e).

Macroconidiophores. *Stipe* septate, hyaline, terminating in a sphaeropedunculate vesicle, (6-)8(-12) μm diam.; stipes (120-)175(-240) μm long. *Conidiophore branches*: primary branches non-septate or rarely 1-septate, (16-)19(-25) x (4-)5 μm; secondary branches non-septate or rarely 1-septate, (11-)15(-20) x (4-)5 μm; tertiary branches non-septate, (9-)12(-14) x (4-)5 μm. *Phialides* elongate, doliiform to reniform, hyaline, non-septate, (9-)13(-17) x 4(-5) μm. *Conidia* cylindrical, hyaline, (1-)3-septate, rounded at both ends, (45-)62(-90) x (4-)6(-7) μm.

Cultural characteristics. *Temperature* min. above 8 C; max. above 35 C; opt. 25 C. This is a high temperature species, with slight to no sporulation on aerial mycelium. *Colony colour* (reverse) 11'D Salmon-buff (Rayner, 1970), 6A4 salmon (Kornerup & Wanscher, 1967). *Chlamydospores* extensive, scattered throughout the medium, forming microsclerotia.

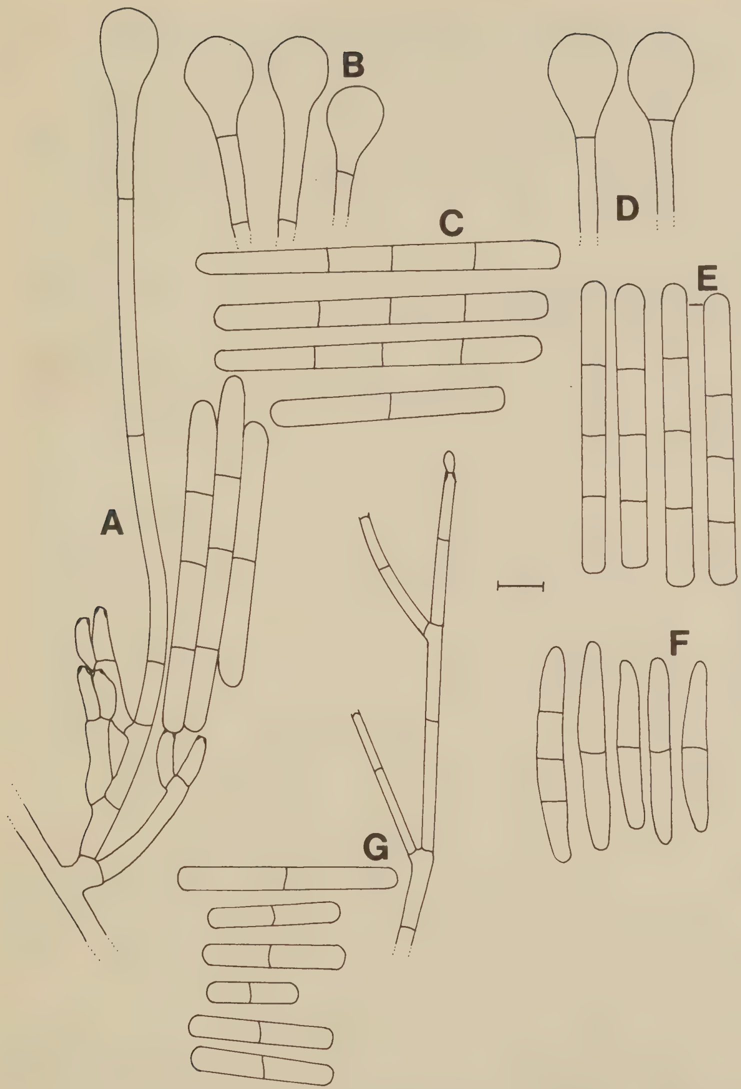


Fig. 15A-G. *Calonectria ilicicola* and its *Cylindrocladium parasiticum* anamorph (bar = 10 μm). A, macroconidiophore; B, sphaeropedunculate vesicles; C, conidia (**IMI** 122262); D, sphaeropedunculate vesicles; E, conidia; F, ascospores (**IMI** 264540); G, microconidiophore and microconidia (**CBS** 190.50).

Microconidiophores. *Stipe* septate, hyaline, terminating in a sphaeropedunculate vesicle, (4-)5(-6) µm diam. *Conidiophore branches*: primary branches non-septate, (19-)21(-26) x (3-)4 µm; secondary branches non-septate, (10-)12(-15) x (3-)4 µm. *Phialides* arise from the ends of branches, in groups of 2-4, cylindrical, hyaline, non-septate, (10-)15(-19) x (3-)4 µm. Collarettes present. *Conidia* cylindrical, hyaline, 1-septate with obtuse ends, (16-)30(-47) x 5(-7) µm.

Teleomorph. *Perithecia* orange to red, 300-500 µm high, 280-400 µm wide, with a warty outer layer and a papillate, periphysate ostiolar region; perithecia turn a blood-red colour in 3 % KOH. *Asci* are clavate, long-stalked, eight-spored, 90-140 x 12-19 µm. *Ascospores* fusoid to falcate, 1-septate, slightly constricted at the septum, (30-)45(-65) x (4-)6(-7) µm; ascospores are 1-septate before ascal dehiscence, and can eventually develop up to three septa.

Type: USA: Georgia, *Arachis hypogaea*, D.K. Bell, 1982, **IMI** 264540 (holotype specimen of anamorph). **Indonesia:** Java, Bogor, *Solanum tuberosum*, K.B. Boedijn & J. Reitsma, **CBS** 190.50 (type culture of teleomorph).
Symptoms: causes a peg, pod and root necrosis of peanuts, but also leaf spot and blighting (Sobers & Alfieri, 1972; Peerally, 1974h).
Hosts: *Acacia* spp., *Arachis hypogaea*, *Araucaria heterophylla* Salisb., *Camellia sasnaqua, Caryota* sp., *Crotalaria anagyroides* H.B. & K., *Carica papaya* L., *Ceratonia siliquia* L., *Cinnamomum kanahirai* Hayata, *Cissus rhombifolia* Vahl., *Eucalyptus* spp., *Euterpe edulis* Mart., *Howeia forsteriana* Becc., *Indigofera hirsuta* L., *Leea coccinea* Planch., *Liquidamber* sp., *Liriodendron tulipifera* L., *Mandevilla* sp., *Medicago sativa* L., *Rivinia humilis* L., *Solanum tuberosum*, *Tephrosia* sp., *Vaccinium* sp. (Filer, 1970; Aragaki, Laemmlen & Nishijima, 1972; Sobers & Alfieri, 1972; Milholland, 1974; Peerally, 1974h; Sobers & Littrell, 1974; Alfenas *et al.*, 1979; Kuhlman *et al.*, 1980; Baxter & Segars, 1989).
Distribution: widely distributed *fide* Peerally (1974h).
Specimens: USA: Georgia, *Arachis hypogaea*, D.K. Bell, 1982, **IMI** 264540 (holotype of anamorph); *Ceratoria siliquia* (?), 1966, **IMI** 122262. **Ceylon:** *Crotalaria* stem, 1949, Loos, **IMI** 35028.
Cultures: Brazil: *Euterpe edulis*, isolated as endophyte, K. Rodrigues, 1991, **PPRI** 4527. **Indonesia:** Bogor, *Solanum tuberosum*, K.B. Boedijn & J. Reitsma, **CBS** 190.50. **Taiwan:** *Cinnamomum kanahirai*, M.J. Wingfield, June 1991, **PPRI** 4213. **USA:** Florida, *Rumohra adiantiformis*,

N.E. El-Gholl, (Viçosa, Brazil **UFV** 34) **PPRI** 4170; Hawaii, *Acacia koa*, M. Aragaki, 1970, **ATCC** 24023; ?, *Arachis hypogaea*, D. Griffin, **PPRI** 4540; ?, *A. hypogaea*, J. Beute, **PPRI** 4521-4524; ?, From soil, D.T. Krigsvold, 1975, **ATCC** 32832; Hawaii, *Carica papaya*, M. Aragaki, 1970, **ATCC** 24024; Hawaii, *Caryota* sp., M. Aragaki, 1991, **PPRI** 4525; Carolina, *Cissus rhombifolia*, C.S. Semer, **PPRI** 4526, **PPRI** 4541; ?, *C. rhombifolia*, S.A. Alfieri & C.L. Schoulties, **ATCC** 46133; Hawaii, *Howeia forsterana*, M. Aragaki, 1988, **PPRI** 4528; Florida, *Indigofera hirsuta*, N. El-Gholl, **PPRI** 4529; Hawaii, *Leea coccinea*, M. Aragaki, 1979, **PPRI** 4530; Hawaii, *Mandevilla* sp., M. Aragaki, 1987, **PPRI** 4531; Hawaii, *Medicago sativa*, M. Aragaki, 1981, **PPRI** 4532; Unknown host, J. Beute, **PPRI** 4533.

Notes: *C. parasiticum* is the only *Cylindrocladium* sp. to have 3-septate conidia and consistent sphaeropedunculate vesicles.

Boedijn & Reitsma (1950) collected a fungus which they identified as *Cylindrocladium ilicicola*, and subsequently described the teleomorph as *Calonectria ilicicola*. When Peerally (1974e) prepared the CMI description for *C. ilicicola*, he found the culture **CBS** 190.50 to be sterile. Because Boedijn & Reitsma (1950) had described the vesicle as globose (sphaeropedunculate), Peerally (1974e) did not acknowledge the name *Calonectria ilicicola*, finding stipes on the type specimen of *Cylindrocladium ilicicola* to have clavate to spathulate vesicles. Peerally (1974e) acknowledged, therefore, that *Calonectria ilicicola* was not the holomorph of *Cylindrocladium ilicicola*.

In a recent examination of the type culture of the teleomorph of *Calonectria ilicicola* (**CBS** 190.50) (Crous *et al.*, 1993e), vesicles were found to be sphaeropedunculate. Vesicle, conidium, ascus and ascospore morphology conformed perfectly with that found in the type of *Calonectria crotalariae* (**IMI** 264540). As the name *Calonectria ilicicola* predates *Calonectria crotalariae*, the latter is treated as a synonym.

The name *Cylindrocladium crotalariae* (Loos) Bell & Sobers had no accompanying Latin description, and was therefore not validly published. In a recent study (Crous *et al.*, 1993e), a Latin description has been provided, and the name *C. parasiticum* Crous, Wingf. & Alfenas proposed for this fungus. *C. parasiticum* is an important pathogen of peanuts, and is often regarded as more important than the notorious *Sclerotium rolfsii* Sacc. on this host (Sobers & Alfieri, 1972). There are several noteworthy articles dealing with the pathogenicity of *C. parasiticum* (Bell, 1967; Rowe *et al.,* 1973; Rowe *et al.*, 1974; Rowe & Beute, 1975; Hau *et al.*, 1982; Tomimatsu & Griffin, 1982; Johnson,

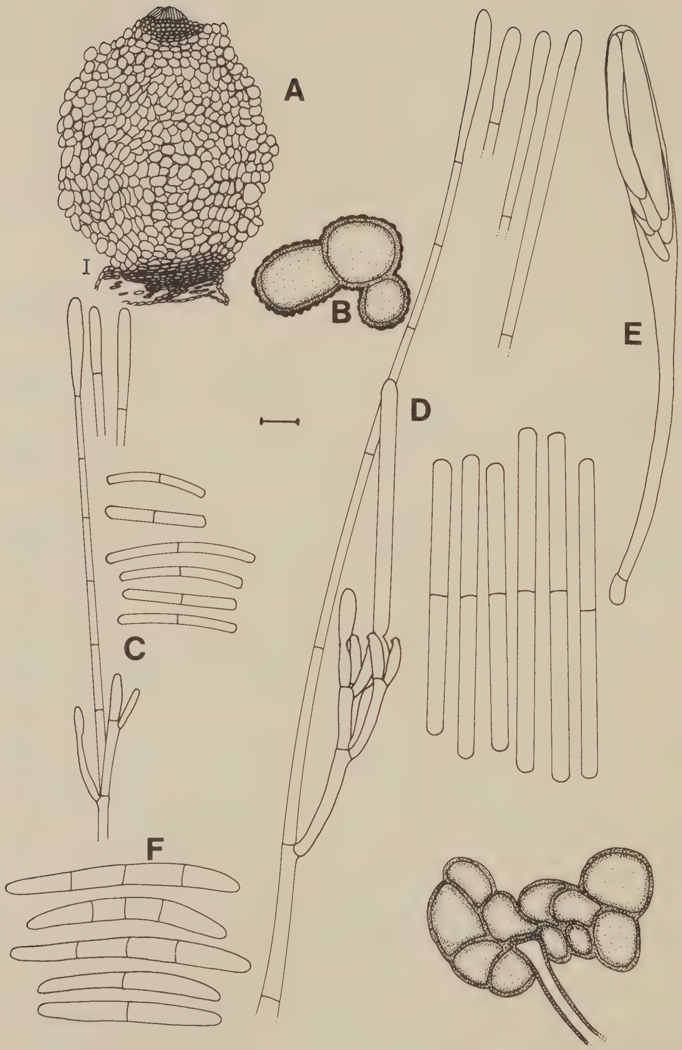


Fig. 16A-F. *Calonectria pteridis*, holomorph of *Cylindrocladium pteridis*. A, perithecium (**PREM** 51033, bar = 20 μm); B, chlamydospores on MEA after 7d; C, microconidiophore, vesicles and conidia on CLA; D, macroconidiophore, clavate vesicles, conidia and microsclerotium on CLA after 7d (**PPRI** 4157); E, ascus; F, ascospores (**PREM** 51033) (bar = 10 μm).

1985). For synergism with nematodes see Diomande *et al.* (1980), and Culbreath *et al.* (1992).

16. Cylindrocladium pteridis Wolf *J. Elisha Mitchell Sci. Soc.* **42:** 59 (1926).
Cylindrocladium macrosporum Sherb. *Phytopathology* **18:** 222 (1928).
Holomorph: **Calonectria pteridis** Crous, Wingfield & Alfenas *Mycotaxon* **46:** 228 (1993).
Illustrations: Figs 16, 50; Wolf (1926); Sherbakoff (1928); Sobers (1968).
Descriptions: Wolf (1926); Sobers (1968); Crous *et al.* (1993d).

Macroconidiophores. *Stipe* septate, hyaline, terminating in a clavate vesicle, (4-)5(-6) μm diam.; stipes (150-)240(-300) μm long. *Conidiophore branches*: primary branches non-septate or rarely 1-septate, (18-)28(-32) x (4-)5(-6) μm; secondary branches non-septate, (16-)20(-30) x (3-)4(-6) μm; tertiary branches non-septate, (14-)18(-22) x (3-)4(-5) μm. *Phialides* elongate, doliiform to reniform, hyaline, non-septate, (12-)16(-22) x 4(-5) μm. *Conidia* cylindrical, hyaline, 1(-3)-septate, rounded at both ends, (62-)82(-121) x 5(-6) μm.

Cultural characteristics. *Temperature* min. above 10 C; max. above 35 C; opt. 30-33 C. This is a high temperature species, with medium sporulation on aerial mycelium. *Colony colour* (reverse) 13K - 13M amber brown to August Brown (Rayner, 1970), 6D8 - 6E7 light brown to cognac (Kornerup & Wanscher, 1967). *Chlamydospores* extensive, dense clusters, forming very large microsclerotia.

Microconidiophores. *Stipe* septate, hyaline, terminating in a clavate vesicle. *Conidiophore branches*: primary branches non-septate, rarely 1-septate, (20-)28(-50) x (3-)5 μm; secondary branches non-septate, rarely 1-septate, (18-)20(-30) x (2-)3(-4) μm; tertiary branches non-septate, (16-)18(-23) x (2-)3 μm. *Phialides* arise from the ends of branches, in groups of 2-4, cylindrical, hyaline, non-septate, (10-)15(-21) x (2-)3(-4) μm, collarettes absent in some isolates, inconspicuous in others. *Conidia* cylindrical, curved or straight, hyaline, 1-septate with obtuse ends, (19-)30(-40) x (2-)4 μm.

Teleomorph. *Perithecia* superficial, borne singly or in small groups, 400-500 x 300-350 μm, with warty outer wall and papillate ostiole, red to red-brown, turning blood-red in 3 % KOH. *Asci* hyaline, clavate, (100-)120(-180) x (9-)15(-27) μm, tapering to a long thin stalk, containing 1-8 ascospores. *Ascospores* hyaline, straight or falcate, 1(-3)-septate, generally not constricted at septa, (30-)52(-75) x (4-)6(-7) µm. Ascospores develop up to six septa once discharged from the ascus.

Type: USA: Florida, Orlando, *Polystichum adiantiforme*, F.A. Wolf, Oct. 1926, **BPI** 414564 (holotype of anamorph); **USA x Brazil:** *Arachnoides adiantiformis*, USA, (?), F. Schickedanz, **ATCC** 34395 x *Eucalyptus grandis*, Brazil, A.C. Alfenas, **PPRI** 4180, **PREM** 51033 (holotype of teleomorph).
Symptoms: causing leaf spots and root disease (Sobers, 1968).
Hosts: *Arachis hypogaea*, *Arachnoides adiantiformis*, *Arecastrum romanzoffianum* (Cham.) Becc., *Asparagus plumosus* Baker, *Callistemon* spp., *Chamaedorea elegans* Schrad., *Cocos nucifera* L., *Collinia elegans* Liebm., *Dryopteris* sp., *Eucalyptus* spp., *Howeia* spp., *Lupinus* spp., *Melaleuca leucadendra* L., *Pinus caribaea* var. *hondurensis*, *Polystichum adiantiforme*, *Rhododendron obtusum*, *Rumhora adiantiformis*, *Strelitzia reginae* Banks and *Washingtonia robusta* Wendl. (Wolf, 1926; Sherbakoff, 1928; Sobers, 1967; Sobers, 1968; Sobers & Alfieri, 1972).
Distribution: Africa, Brazil, India, U.S.A. (Florida) (Sobers, 1968; Sobers & Alfieri, 1972; Bedendo & Krügner, 1987).
Specimens: Africa: *Pinus caribaea* var. *hondurensis*, 1972, Ivory, **IMI** 164169; *P. oocarpa*, Ivory, **IMI** 164168. **India:** *Cocos nucifera*, ?, 1973, **IMI** 174348. **USA:** *Washingtonia robusta*, C.D. Sherbakoff, Jan 1928, **BPI** 414558; Florida, near Sebring, *Washingtonia robusta*, C.D. Sherbakoff, Dec. 1927, **BPI** 414559; Florida, Orlando, *Polystichum adiantiforme*, F.A. Wolf, Oct. 1926, **BPI** 414564.
Cultures: Brazil: unknown host, J.C. Dianese, (Viçosa, Brazil, No. **UFV** 43), **PPRI** 4157; needles of a *Pinus* sp., T.L. Krügner, (Viçosa, Brazil, No. **UFV** 10) **PPRI** 4177, **IMI** 354524; needles of *Pinus caribaea*, T.L. Krügner, (Viçosa, Brazil, No. **UFV** 37) **PPRI** 4178; *Eucalyptus grandis* leaves, A.C. Alfenas, (Brazil, Viçosa, No. **UFV** 105) **PPRI** 4180, **IMI** 354530. **USA:** *Arachnoides adiantiformis*, F. Schickedanz, 1974, **ATCC** 34395; Florida, *Rumohra adiantiformis*, N.E. El-Gholl, (Brazil, Viçosa, No. **UFV** 50) **PPRI** 4179; *Eucalyptus* sp., C.S. Hodges, (Brazil, Viçosa, No. **UFV** 92) **PPRI** 4181, **IMI** 354532.
Notes: *C. pteridis* has the largest conidia of all 1-septate *Cylindrocladium* spp., its conidia frequently exceeding 100 µm in length. Furthermore, it is the only *Cylindrocladium* sp. that produces curved microconidia.

Although *C. macrosporum* is a synonym of *C. pteridis*, many researchers continue to use the name *C. macrosporum* (Renard &

Viennot-Bourgin, 1973; Renard & Quillec, 1979; Ahmad & Ahmad, 1982) rather than the valid name *C. pteridis*.

Sobers (1968) showed that the original type culture of *C. macrosporum* could produce microconidia when cultured on WA. This was the first time that a microconidial state had been described in a species of *Cylindrocladium*. In the original description (Sherbakoff, 1928), microconidia are illustrated, but were not mentioned prior to the study in which Sobers (1968) synonymised *C. macrosporum* with *C. pteridis*. Sobers (1968) stated that microconidia did not give rise to both conidial types when single-spored. In contrast, in this study single microconidia from *C. pteridis* and other *Cylindrocladium* spp. could give rise to both conidial types in culture.

A heterothallic *Calonectria* teleomorph for *C. pteridis* was recently described (Crous *et al.*, 1993d). Fertile perithecia could be obtained only by incubating CLA plates at 15 C for 2 mo.

17. **Cylindrocladium quinqueseptatum** Boedijn & Reitsma *Reinwardtia* **1:** 59 (1950).

Holomorph: **Calonectria quinqueseptata** Figueiredo & Namekata *Arch. Insti. Biol. Sao Paulo* **34:** 93 (1967).

Illustrations: Fig. 17; Boedijn & Reitsma (1950); Figueiredo & Namekata (1967).

Descriptions: Boedijn & Reitsma (1950); Figueiredo & Namekata (1967).

Macroconidiophores. (Measurements of this species not obtained from CLA, but from specimens cited below). *Stipe* septate, hyaline, terminating in a clavate vesicle, (3-)5(-6) μm diam.; stipes (150-)275(-380) μm long. *Conidiophore branches*: primary branches non-septate or rarely 1-septate, (20-)28(-55) x (3-)5(-6) μm; secondary branches non-septate, (15-)17(-20) x (3-)4(-5) μm; tertiary branches (and other branches, up to six), non-septate, (12-)15(-19) x (3-)4(-5) μm. *Phialides* cylindrical to allantoid or slightly doliiform, hyaline, non-septate, (13-)17(-26) x 4(-5) μm. *Conidia* cylindrical, hyaline, (1-)5(-6)-septate, rounded at both ends, (61-)84(-101) x (5-)6(-7) μm.

Cultural characteristics. *Temperature* min. above 10 C; max. below 35 C; opt. 25 C. This is a high temperature species, with no or only sparse sporulation on aerial mycelium. *Colony colour* (reverse) 15'B ochraceous buff (Rayner, 1970), 5B6 apricot (Kornerup & Wanscher,

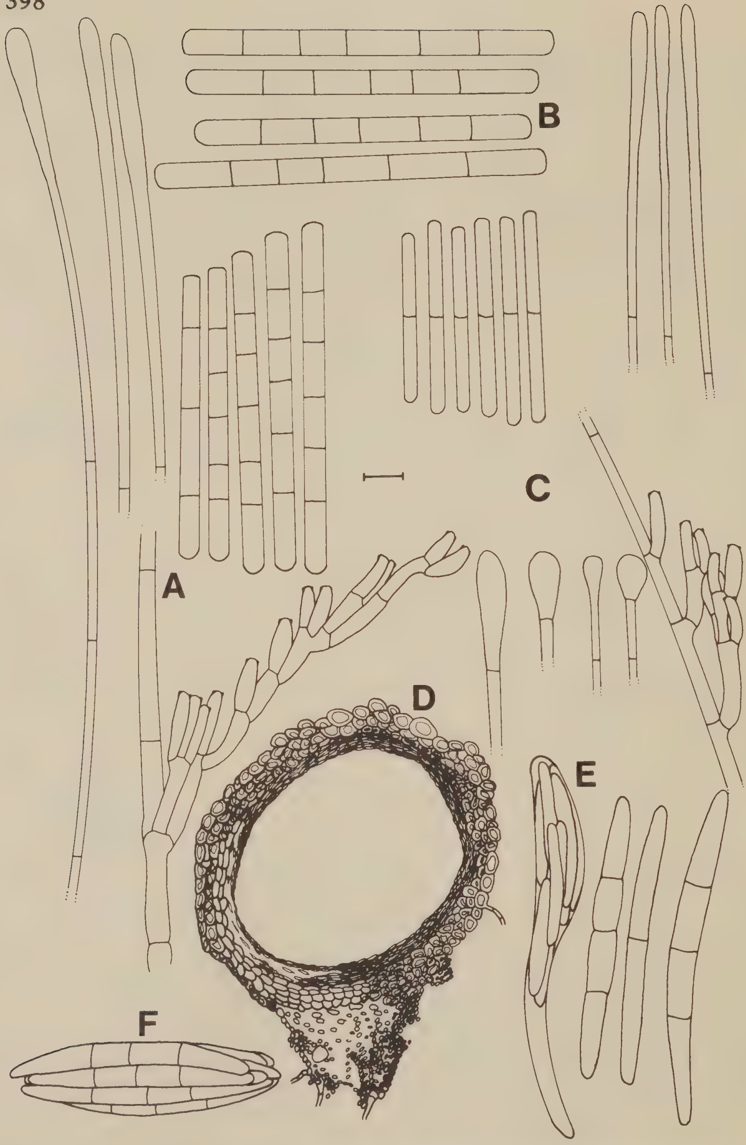


Fig. 17A-F. *Calonectria quinqueseptata*, holomorph of *Cylindrocladium quinqueseptatum*. A, macroconidiophore, clavate vesicles and conidia on PSA (**IMI** 114953); B, macroconidia and vesicles on PSA (**IMI** 201927); C, microconidiophore, clavate to sphaeropedunculate vesicles and conidia on PSA (**IMI** 114953) (bar = 10 μm); D, v. s. through a perithecium (bar = 20 μm); E, F, ascus and ascospores (**NY** 68-4, type) (bar = 10 μm).

1967). *Chlamydospores* extensive, arranged in fine chains, forming microsclerotia.

Microconidiophores. *Stipe* septate, hyaline, terminating in a clavate to sphaeropedunculate vesicle when present. *Conidiophore branches*: primary branches non-septate, (15-)18(-24) x 3(-4) μm; secondary branches non-septate, (8-)12(-18) x (2-)3(-4) μm. *Phialides* arise singly from the ends of branches, or are arranged in groups of 2-4, cylindrical, hyaline, non-septate, (11-)13(-15) x (2-)3 μm, collarettes absent. *Conidia* cylindrical, hyaline, 1-septate with obtuse ends, (40-)46(-50) x 4(-5) μm.

Teleomorph. *Perithecia* globose to ovoid, 360-580 x 300-440 μm, with warty outer wall and papillate ostiole, orange to red-brown, turning blood-red in 3 % KOH. *Asci* hyaline, clavate, 76-126 x 13-22 μm, tapering to a long thin stalk, containing eight ascospores. *Ascospores* hyaline, straight or falcate, (1-)3-septate, not or slightly constricted at septa, (54-)76(-100) x (4-)7(-8) μm.

Type: Brazil: Sao Paulo, Araruama farm, Jacupiranga, leaf spots on *Annona squamosa*, M.B. Figueiredo, 1965, C.T. Rogerson, **NY** 68-3 (holotype).
Symptoms: damping-off, seedling blight, root-rot, stem infection, leaf and shoot blights, tip blight, dieback (Sharma & Mohanan, 1982; Mohanan & Sharma, 1985b).
Hosts: *Ageratum* sp., *Annona squamosa* L., *Camellia sinensis*, *Clerodendron* sp., *Eucalyptus* spp., *Eugenia* sp., *Euphorbia* sp., *Hevea* sp., *Lucas* sp., *Malpighia* sp., *Manilkana* sp., *Scolopendrium* sp., *Sida* sp., *Synedrella* sp. and *Terminalia paniculata* Roth. (Peerally, 1974c; Sulochana *et al.*, 1982; Mohanan & Sharma, 1985b).
Distribution: Australia, Brazil, Indonesia, Malaysia, Mauritius, India, Sri Lanka, Hong Kong (Peerally, 1974c; Pitkethley, 1976; Sharma & Mohanan, 1982).
Specimens: Australia: *Eucalyptus phoenicea* F. Muell., 1976, Pitketh., **IMI** 201927. **Brazil:** Sao Paulo, June 1985, leaves of *Annona squamosa*, M.B. Figueiredo & T. Namekata, **NY** 68-3 (type of *Calonectria quinqueseptata*); Sao Paulo, leaves of *Eucalyptus* sp., M.B. Figueiredo & T. Namekata, Nov. 1979, **NY** 68-4 (paratype); *Annona* sp., Campinas, Herbario da Seccao de Botanico, IACM 2682; **USA:** *Scolopendrium* sp., 1965, **IMI** 114953.
Culture: USA: *Scolopendrium* sp., 1965, **ATCC** 16550.

Notes: of all the *Cylindrocladium* spp. that have multi-septate conidia and clavate vesicles, *C. quinqueseptatum* is the only species with primarily 5-septate conidia.

A collection lodged at IMI (**IMI** 114953) as *C. pteridis*, was found to represent *C. quinqueseptatum*. This collection produced microconidia, and single-spore isolations gave rise to both conidial types. The dried microconidial culture (representing both conidial types) is described above. Vesicles of the microconidial state varied from clavate to sphaeropedunculate, which is unusual, as vesicles of microconidiophores usually have exactly the same morphology as those of macroconidiophores. This variation is attributed to cultural conditions. There is no doubt, however, that the microconidiophores belong to *C. quinqueseptatum*, as the dried culture representing both states was derived from a single microconidium.

Sehgal (1983) reports *C. quinqueseptatum* to be widely distributed in India and regards it as a very serious pathogen of *Eucalyptus*. Anahosur *et al.* (1976) demonstrated the toxic effects of culture filtrates to *Eucalyptus* cuttings, while Sharma & Mohanan (1991b) found evidence of physiological strains in this species.

18. Cylindrocladium reteaudii (Bugn.) Boesewinkel *Trans. Br. mycol. Soc.* **78:** 554 (1982).

Cylindrocarpon reteaudii Bugn., *Encycl. Mycol.* **11:** 189 (1939) (described as *reteaudi*).

Cylindrocladium macrosporum var. *hederae* Arn. *Bull. Soc. mycol. Fr.* **68:** 205 (1952) (*nom. nud.*).

Cylindrocladium hederae (Arn.) Peerally CMI Descriptions of Pathogenic fungi and Bacteria No. 426 (1974f) (*nom. nud.*).

Cylindrocladium hederae Arn. *ex* Peerally *Mycotaxon* **40:** 335 (1991).

Cylindrocladium leucothoes El-Gholl, Leahy & Schubert *Can. J. Bot.* **67:** 2530 (1989) (as *leucothoeae*).

Holomorph: **Calonectria reteaudii** (Bugn.) Booth *Mycol. Pap.* **104:** 41 (1966).

Neonectria reteaudii Bugn. *Encycl. Mycol.* **11:** 189 (1939) (as *reteaudi*).

Calonectria hederae Arnaud *Bull. Soc. Mycol. France* **68:** 214 (1952) (*nom. nud.*).

Calonectria hederae Booth & Murray *Trans. Br. mycol. Soc.* **43:** 70 (1960).

Illustrations: Figs 18, 49; Bugnicourt (1939); Booth (1966); Peerally (1974f); El-Gholl *et al.* (1989).

Descriptions: Bugnicourt (1939); Arnaud, 1952; Booth (1966); Peerally (1974f); El-Gholl *et al.* (1989); Crous & Wingfield (1992).

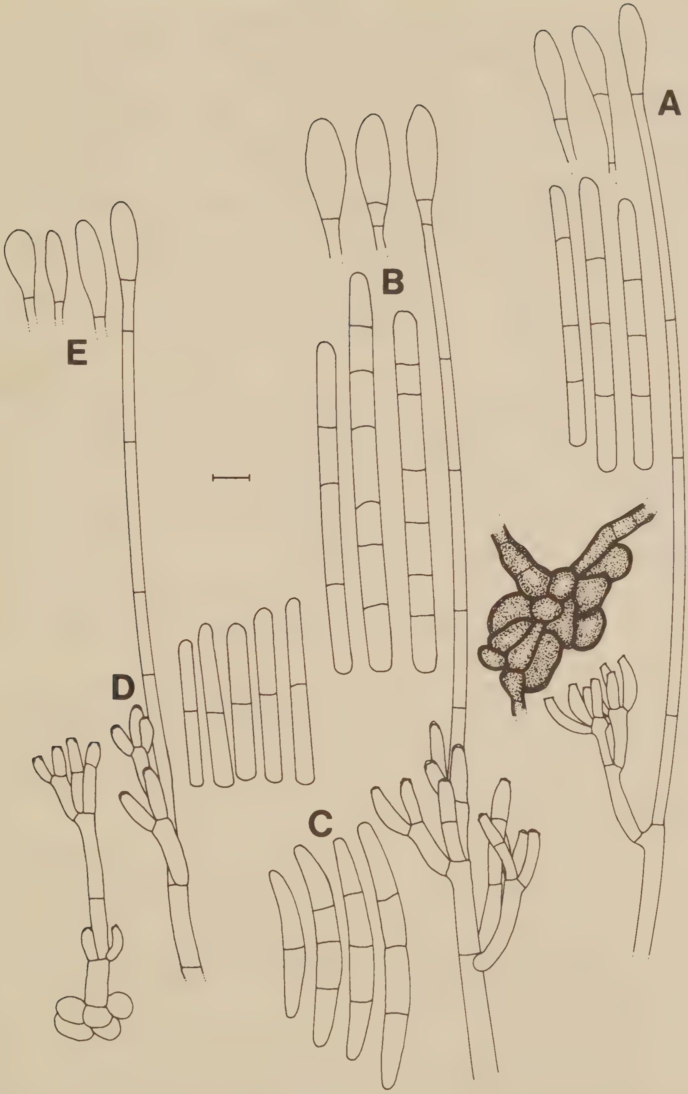


Fig. 18A-E. *Calonectria reteaudii* and its *Cylindrocladium reteaudii* anamorph (bar = 10 μm). A, macroconidiophore, ellipsoidal vesicles, conidia and microsclerotium (ATCC 64824); B, macroconidiophore, ellipsoidal vesicles and conidia; C, ascospores; D, microconidiophores and microconidia; E, ellipsoidal microvesicles (**CPC** 599).

Macroconidiophores. *Stipe* septate, hyaline, terminating in an ellipsoidal or ovoid vesicle, (4-)6(-8) μm diam.; stipes (160-)185(-245) μm long. *Conidiophore branches*: primary branches non-septate or rarely 1-septate, (11-)19(-36) x (3-)4(-5) μm; secondary branches non-septate, (12-)15(-18) x (3-)4 μm; tertiary branches non-septate, (10-)14(-17) x (3-)4 μm. *Phialides* cylindrical to allantoid or slightly doliiform, hyaline, non-septate, (10-)15(-20) x 3(-4) μm. *Conidia* cylindrical, hyaline, (1-)3(-6)-septate, rounded at both ends, (60-)80(-105) x (5-)6(-7) μm. If incubated as outlined in the materials and methods section of this paper, conidia develop only three septa after 7 d. However, on older cultures, conidia develop up to six septa and are up to 105 μm long.

Cultural characteristics. *Temperature* min. above 8 C; max. below 35 C; opt. 25 C. This is a high temperature species, with medium sporulation on aerial mycelium. *Colony colour* (reverse) 17B deep chrome (Rayner, 1970), 4B8 yolk yellow (Kornerup & Wanscher, 1967). *Chlamydospores* slight to medium in density, appearing scattered throughout medium, forming microsclerotia.

Microconidiophores. *Stipe* septate, hyaline, terminating in an ellipsoidal to ovoid vesicle when present. *Conidiophore branches*: primary branches non-septate, (10-)15(-20) x (4-)5(-6) μm; secondary branches non-septate, (10-)15 x (4-)5 μm. *Phialides* arising singly from the ends of branches, or are arranged in groups of 2-4, are cylindrical to doliiform, hyaline, non-septate, 10(-15) x 3(-4) μm, collarettes absent. *Conidia* cylindrical, hyaline, 1-septate with obtuse, frequently slightly swollen ends, (45-)47(-50) x (3-)5 μm.

Teleomorph. *Perithecia* ovoid to globose, 200-400 x 250-380 μm, with warty outer wall and papillate ostiole, orange to red, turning blood-red in 3 % KOH. *Asci* hyaline, clavate, 100-180 x 15-20 μm, tapering to a long thin stalk, containing eight ascospores. *Ascospores* hyaline, straight or falcate, (1-)3-septate, not or slightly constricted at septa, (36-)60(-70) x (5-)6(-7) μm.

Type: South East Asia (Vietnam): *Smithia bequaertii* De Wild., F. Bugnicourt, **IMI** 55922 (dried culture, *ex* holotype). **France:** *Hedera helix* leaf, G. Arnaud, 1948, **IMI** 39232 (neotype of teleomorph). **Great Britain:** *H. helix* leaf, 1958, **IMI** 75300 (neotype of teleomorph). **Symptoms:** leaf spots and root discolouration (Peerally, 1974f).

Hosts: *Eucalyptus saligna, Hedera helix* L., *Smithia bequaertii*, *Leucothoe axillaris* (Bugnicourt, 1939; Peerally, 1974f; El-Gholl *et al.*, 1989).
Distribution: Brazil, France, Great Britain, U.S.A (Florida) (Peerally, 1974f; El-Gholl *et al.*, 1989).
Specimens: France: *Calonectria hederae*, *Hedera helix* leaves, G. Arnaud, 1948, **IMI** 39232. **Great Britain:** *Calonectria hederae*, *Hedera helix* leaf, 1958, **IMI** 75300; *H. helix* leaf, 1978, **IMI** 241261. **Indo China:** *Cylindrocarpon reteaudii*, on *Smithia bequaertii*, F. Bugnicourt, **IMI** 55922 (dried culture derived from holotype, Herb Paris).
Culture: USA: Florida, *C. leucothoeae*, from *Leucothoeae axillaris* leaves, El-Gholl, Feb. 1988, **ATCC** 64824 (type culture). **Brazil:** Sao Paulo, leaf spots on young *E. saligna* trees, P.W. Crous, Apr. 1993, **CPC** 599.
Notes: Bugnicourt (1939) described *Cylindrocarpon reteaudii* and *Neonectria reteaudii* as a new holomorph from Indo China. Booth (1966) transferred the teleomorph to *Calonectria*, and Boesewinkel (1982a) the anamorph to *Cylindrocladium*. In a recent study (Crous & Wingfield, 1992), *C. reteaudii* was compared with *C. leucothoes* and *C. hederae*. These three species were shown to represent the same taxon, *C. reteaudii*, characterised by 1-(3)-6-septate conidia averaging 72 μm in length, and ellipsoidal to ovoid vesicles. A recent collection from *E. saligna* (**CPC** 599) showed that this fungus is also present in Brazil.

19. Cylindrocladium scoparium Morgan Bot. Gaz. **17:** 191 (1892).
Cylindrocladium pithecolobii Petch Ann. R. Bot. Gard. Peradeniya **6:** 244 (1917).
Diplocladium cylindrosporum Ell. & Everh. *Bull. Torrey Bot. Cl.* **27:** 58 (1900).
Cylindrocladium scoparium var. *brasiliensis* Batista & Ciferri *Boletim da S.A.I.C. Pernamubco* **18:** 190 (1951).
Cylindrocladium brasiliensis (Batista & Ciferri) Peerally CMI Descriptions of Pathogenic Fungi and Bacteria No. 427 (1974).
Cylindrocladium ellipticum Alfieri, Seymour & Sobers *Phytopathology* **60:** 1213 (1970).
Holomorph: **Calonectria morganii** Crous, Alfenas & Wingfield *Mycol. Res.* **97:** 706 (1993).
Illustrations: Figs 19, 51-54; Booth & Gibson (1973); Alfieri *et al.* (1970); Crous *et al.* (1993a).
Descriptions: Booth & Gibson (1973); Crous *et al.* (1993a).

Macroconidiophores. Stipe septate, hyaline, terminating in a obovoid to pyriform or ellipsoidal vesicle, (6-)7(-8) μm diam.; stipes

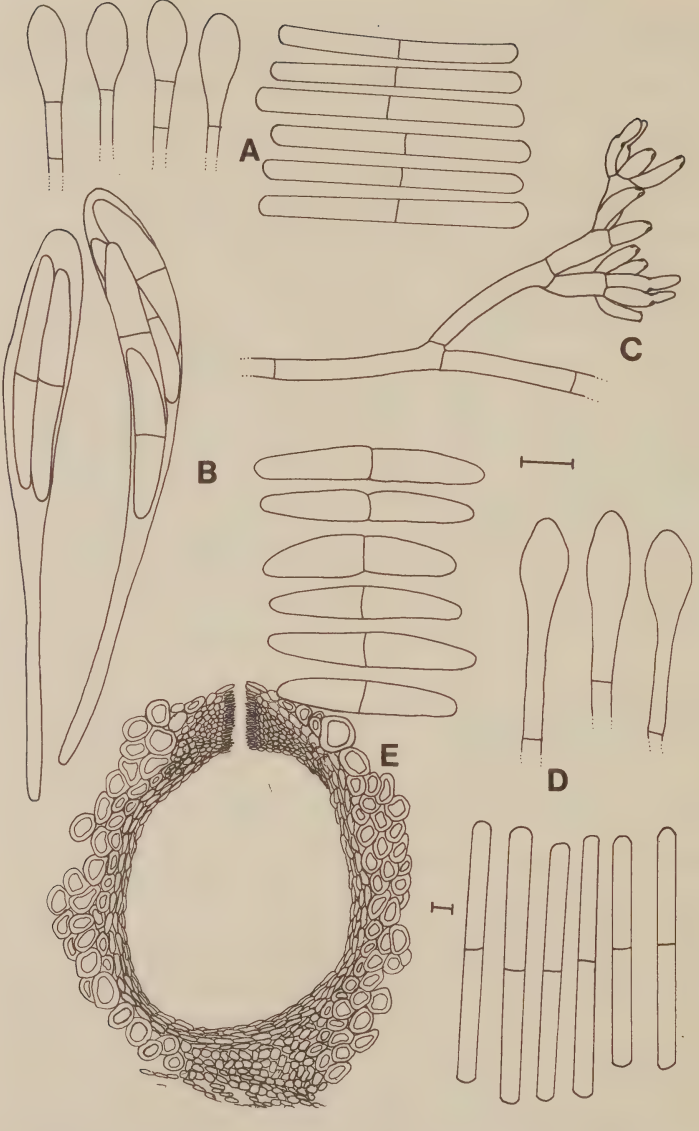


Fig. 19A-E. *Calonectria morganii* and its *Cylindrocladium scoparium* anamorph. A, pyriform to ellipsoidal vesicles and conidia (**BPI** 414576); B, asci and ascospores (**PREM** 51042, type); C, conidiophore; D, ellipsoidal vesicles and conidia on CLA (**ATCC** 46300, bar = 10 μm); E, v. s. through a perithecium (**PREM** 51042, bar = 20 μm).

(150-)173(-195) μm long. *Conidiophore branches*: primary branches non-septate or 1-septate, (11-)24(-40) x (4-)5 μm; secondary branches non-septate, (11-)16(-20) x 4(-5) μm; tertiary branches non-septate, (10-)13(-15) x 4(-5) μm. *Phialides* doliiform to reniform, hyaline, non-septate, (9-)11(-15) x (3-)4 μm. *Conidia* cylindrical, hyaline, 1-septate, rounded at both ends, (40-)45(-66) x (3-)4(-5) μm. *Microconidiophores*, absent.

Cultural characteristics. *Temperature* min. above 5 C; max. above 35 C; opt. 25-30 C. This is a eurythermal species, with medium sporulation on aerial mycelium. *Colony colour* (reverse) 13K - 17'I - 15"I, amber brown to buckthorn brown to sayal brown (Rayner, 1970), 5D6 - 6D8, or 5C6 - 6C7, pompeian yellow to light brown, or oak brown to reddish golden (Kornerup & Wanscher, 1967). *Chlamydospores* extensive, dense, distributed throughout medium, forming microsclerotia.

Teleomorph. *Perithecia* superficial, borne singly or in groups, globose or subglobose, 280-520 x 280-400 μm, red-brown to red, with rough warted outer wall and papillate ostiole. *Asci* hyaline, clavate, (75-)80(-100) x (8-)10(-15) μm, tapering to a long thin stalk, containing 1-8 ascospores. *Ascospores* hyaline, straight to falcate, 1-septate, not or slightly constricted at central septum, (24-)37(-49) x (4-)7(-8) μm. *Ascospores* developing up to three septa once discharged from ascus.

Type: USA: *Gleditsia triacanthos* Hance, Preston, Ohio, A.P. Morgan, **BPI** 414576 (lectotype of anamorph); **ATCC** 46300 (USA, *Leucothoe catesbaei*) x **PPRI** 4731 (Brazil, *Anacardium* sp.), July 1992, P.W. Crous, **PREM** 51042 (holotype of teleomorph).
Symptoms: damping off, root rots, stem cankers, leaf spotting, needle blight, epicormic growth, death of trees, seedling and shoot blight (Batista, 1951; Peerally, 1974g; Cordell & Skilling, 1975; Cordell & Rowan, 1975).
Hosts: Booth & Gibson (1973) report *C. scoparium* to have a wide host range, infecting mainly woody plants (particularly eucalypts and pine), but also beet, strawberry and watermelon. French & Menge (1978) stated that it occurs on well over 66 plant genera.
Distribution: *C. scoparium* has been reported from numerous countries (Booth & Gibson, 1973). However, the establishment of another name for South African and Brazilian isolates previously referred to as *C. scoparium*, suggests that many of these reports might be of *C.*

candelabrum. An accurate representation of the distribution and host range of this fungus can, therefore, not be presented at this stage.
Specimens: Brazil: Recife, *Eucalyptus* seedlings, A.C. Batista, 11 Sept. 1950, **IMI** 43688 (*ex* holotype, *C. brasiliensis*); **USA: ATCC** 46300 (USA, *Leucothoe catesbaei*) x **PPRI** 4731 (Brazil, *Anacardium* sp.), July 1992, P.W. Crous, **PREM** 51042 (holotype specimen); **ATCC** 46300 (USA, *Leucothoe catesbaei*) x **ATCC** 38227 (USA, *Mahonia bealei*), July 1992, P.W. Crous, **PREM** 51043 (paratype specimen); Preston, Ohio, *Gleditsia triacanthos*, A.P. Morgan, 1893, **BPI** 414576 (Lectotype designated here), **BPI** 414577; Preston, Ohio, *Juglans nigra*, A.P. Morgan, 1893, **BPI** 414578.
Cultures: Brazil: CE, Fortaleza, *Anacardium* sp., D.O. Freire, **PPRI** 4731; T.R. Ciferri, **CBS** 230.51 Type of *C. brasiliensis*, (**IMI** 299576). **USA:** *Mahonia bealei*, S.A. Alfieri, 1970, **ATCC** 38227 (*C. ellipticum*, type); Florida, *Rhododendron* sp., C.R. Semer, (Viçosa, Brazil, No. **UFV** 11), **PPRI** 4144; unknown host, A. Rossman, (Viçosa, Brazil, No. **UFV** 39), **PPRI** 4154; North Carolina, *Leucothoë caresbaei*, D.M. Benson, 1981, **ATCC** 46300; **Rosa** sp., N. El-Gholl, P90.1445, **PPRI** 4732; Florida, *Ilex vomitoria*, N. El-Gholl, P90.1479, **PPRI** 4733.
Notes: *C. scoparium* is morphologically very similar to *C. floridanum*, *C. ovatum* and *C. candelabrum*. However, *C. scoparium* has ellipsoidal to obovoid vesicles, whereas vesicles are ovoid for *C. ovatum*, sphaeropedunculate for *C. floridanum*, and ellipsoidal to obpyriform for *C. candelabrum*. The teleomorph of *Calonectria kyotensis*, (the holomorph of *C. floridanum*), can be distinguished from the teleomorphs of the other two species by its smaller ascospores. Furthermore, *C. scoparium* isolates from North America can be distinguished from those of *C. candelabrum* through sexual incompatibility. Isolates of *C. scoparium* also have different electrophoretic protein profiles from those of *C. candelabrum* (Crous *et al.*, 1993a).

20. Cylindrocladium spathiphylli Schoulties, El-Gholl & Alfieri *Mycotaxon* **16:** 268 (1982).
Holomorph: **Calonectria spathiphylli** El-Gholl, Uchida, Alfenas, Schubert, Alfieri & Chase *Mycotaxon* **45:** 296 (1992).
Illustrations: Figs 20, 55, 56; Schoulties *et al.* (1982); El-Gholl *et al.* (1992).
Description: Schoulties *et al.* (1982); El-Gholl *et al.* (1992).

Macroconidiophores. *Stipe* septate, hyaline, terminating in a globose, ellipsoid or spathulate vesicle, (8-)12(-15) μm diam.; stipes

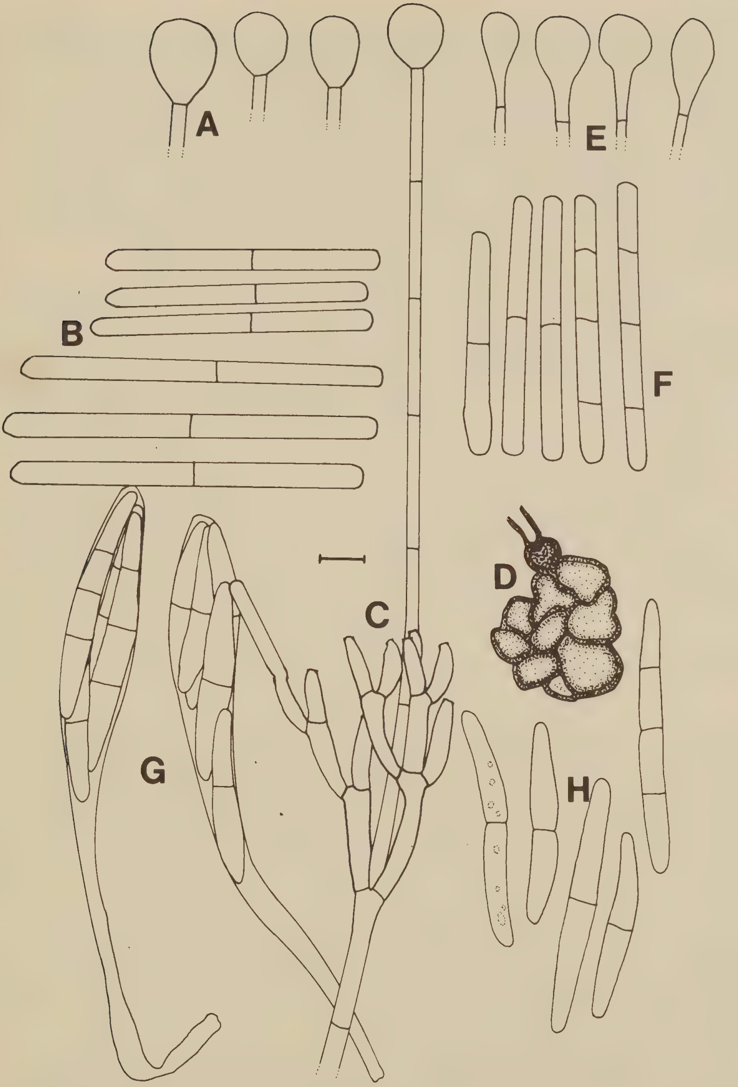


Fig. 20A-H. *Cylindrocladium spathiphylli* (bar = 10 μm). A, globose to sphaeropedunculate vesicles; B, conidia; C, conidiophore; D, microsclerotium on CLA (**ATCC** 44730, *ex* type); E, globose to ellipsoid to sphaeropedunculate vesicles; F, conidia (Aragaki 1569); G, asci; H, ascospores (**FLAS** F55655, type).

(170-)217(-260) µm long. *Conidiophore branches*: primary branches non-septate or rarely 1-septate, (18-)30(-40) x (4-)5(-6) µm; secondary branches non-septate, (18-)22(-30) x (4-)5(-6) µm; tertiary branches non-septate, (16-)19(-25) x (4-)5 µm; quaternary branches non-septate, (11-)15(-20) x 4(-5) µm. *Phialides* elongate, doliiform to reniform, hyaline, non-septate, (12-)17(-21) x (3-)4(-5) µm. *Conidia* cylindrical, hyaline, 1(-3)-septate, rounded at both ends, (45-)68(-120) x (5-)6(-7) µm. *Microconidiophores* unknown.

Cultural characteristics. *Temperature* min. above 10 C; max. below 35 C; opt. 25 C. This is a high temperature species, with medium sporulation on aerial mycelium. *Colony colour* (reverse) 13"K verona brown (Rayner, 1970), 5E7 linoleum brown (Kornerup & Wanscher, 1967). *Chlamydospores* extensive, dense, dispersed throughout the medium, forming microsclerotia.

Teleomorph. *Perithecia* superficial, borne singly or in groups, globose or subglobose, 380-655 x 340-650 µm, orange to red, with rough, warty outer wall and papillate ostiole. *Asci* hyaline, clavate, (120-)172(-230) x (7-)15(-25) µm, tapering to a long thin stalk, containing (2-)8 ascospores. *Ascospores* hyaline, straight to falcate, 1(-3)-septate, slightly constricted at septa, guttulate, (22-)45(-65) x (3-)5(-7) µm.

Type: USA: Florida, *Spathiphyllum* sp., C.L. Schoulties, 1982, **ATCC** 44730 (holotype of anamorph); Florida, induced on leaf segment of *Howeia forsteriana*, by mating P86-210 (from *Heliconia psittacorum*, K.I. Kavouras, Dover, Florida, 20 Jan. 1986) and P 87-167 (from *Heliconia* sp., C.L. Lippincott, Miami, Florida, 9 Jan. 1987, **FLAS** 55655 (holotype of teleomorph).
Symptoms: Root, stem and foliar disease (Schoulties *et al*., 1982).
Hosts: *Araucaria heterophylla*; *Spathiphyllum* spp.; *Heliconia* spp.; *Strelitzia nicolai* Regel & Körn; *Ludwigia palustris* (L.) Elliott (Schoulties *et al*., 1982; El-Gholl *et al*., 1992).
Distribution: Australia, Italy, Florida, U.S.A (Florida, Hawaii) (Schoulties *et al*., 1982; Forsberg, 1988; Carrai & Carribaldi, 1990).
Cultures: USA: Florida, *Spathiphyllum* sp., C.L. Schoulties, 1982, **ATCC** 44730; Hawaii, *Araucaria heterophylla*, M. Aragaki, 1987, No. 1568, **IMI** 354528; No. 1569, **IMI** 354529.
Notes: *C. spathiphylli* is currently the only known *Cylindrocladium* sp. with globose vesicles. In this study, however, we have found as reported by Uchida & Aragaki (1992) that some vesicles can be slightly ellipsoidal.

Furthermore, Hawaiian isolates studied also showed conidia to be 1(-3) septate, as observed by El-Gholl *et al.* (1992). This taxon is, however, primarily distinguished from *C. parasiticum* (sphaeropedunculate vesicles), by having mainly 1-septate conidia. Other *Cylindrocladium* spp. with 1-septate conidia and sphaeropedunculate vesicles are distinguished from *C. spathiphylli* by having curved conidia (*C. curvatum*) or lateral stipes and smaller conidia (*C. floridanum*).

21. Cylindrocladium spathulatum El-Gholl, Kimbrough, Barnard, Alfieri & Schoulties *Mycotaxon* **26:** 159 (1986).
Holomorph: **Calonectria spathulata** El-Gholl, Kimbrough, Barnard, Alfieri & Schoulties *Mycotaxon* **26:** 159 (1986).
Illustrations: Fig. 21; El-Gholl *et al.* (1986).
Description: El-Gholl *et al.* (1986).

Macroconidiophores. *Stipe* septate, hyaline, terminating in a clavate to spathulate vesicle, (3-)6(-9) µm diam.; stipes (105-)173(-225) µm long. *Conidiophore branches*: primary branches non-septate or rarely 1-septate, (12-)22(-37) x (3-)4(-5) µm; secondary branches non-septate, (12-)18(-25) x (3-)4(-5) µm; tertiary branches non-septate, (14-)16(-20) x 3(-4) µm. *Phialides* elongate, doliiform to reniform, hyaline, non-septate, (11-)14(-18) x (3-)4(-5) µm. *Conidia* cylindrical, hyaline, 1(-3)-septate, rounded at both ends, (48-)58(-75) x (4-)5(-6) µm. When cultures are incubated under conditions other than that reported here, conidia are observed to have larger dimensions. *Microconidiophores* unknown.

Cultural characteristics. *Temperature* min. below 5 C; max. below 33 C; opt. 25 C. This is a low temperature species, with medium sporulation on aerial mycelium. *Colony colour* (reverse) 13D - 15F cupucine orange to pale-yellow orange (Rayner, 1970), 5B6 - 4A5 apricot yellow to butter yellow (Kornerup & Wanscher, 1967). *Chlamydospores* in medium numbers (fewer than *C. ilicicola*), scattered to occurring in chains, forming microsclerotia.

Teleomorph. *Perithecia* globose to ovoid, 318-536 x 273-457 µm, with warty outer wall and papillate ostiole, orange-red in colour, turning blood-red in 3 % KOH. *Asci* hyaline, clavate, 87-162 x 10-24 µm, tapering to a long thin stalk, containing eight ascospores. *Ascospores* hyaline, straight or falcate, 1(-3)-septate, not or slightly constricted at central septum, (25-)40(-48) x (4-)5(-7) µm.

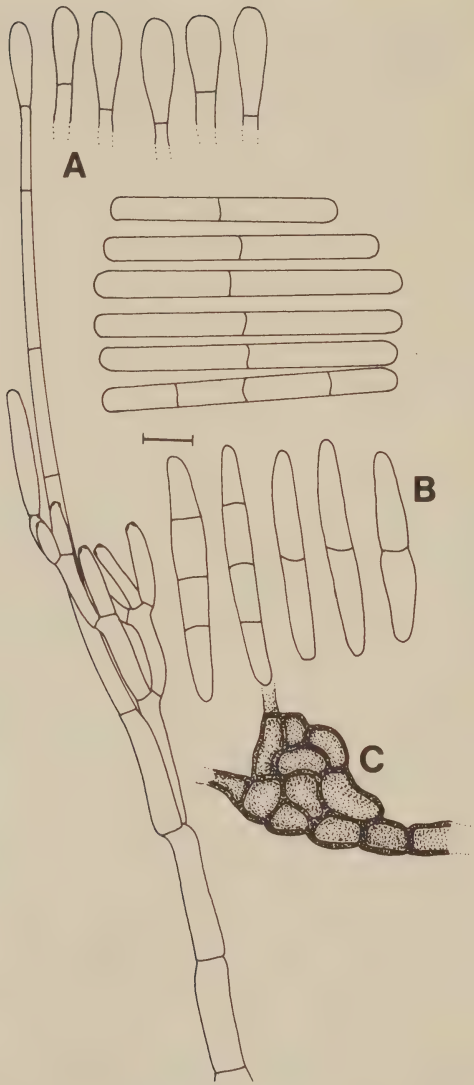


Fig. 21A-C. *Calonectria spathulata* and its *Cylindrocladium spathulatum* anamorph (bar = 10 μm). A, conidiophore, clavate to spathulate vesicles and conidia on CLA (**ATCC** 62616, *ex* type); B, ascospores (**FLAS** F54257); C, microsclerotium (**ATCC** 62616).

Type: Brazil: Santa Catarina, leaves of *Eucalyptus viminalis* Labill., El-Gholl, 1983, **FTCC** 1001, **FLAS** F54257 (holotype).
Symptoms: leaf spots (El-Gholl, *et al.,* 1986).
Hosts: *E. viminalis*, *E. cloeziana*, *E. grandis* (El-Gholl, *et al.,* 1986).
Distribution: Brazil (El-Gholl, *et al.*, 1986).
Cultures: Brazil: Minas Gerais, *Eucalyptus grandis*, C. S. Hodges, (Beltsville, Maryland, AR 1844), **PPRI** 4173, **IMI** 354522; *E. viminalis* leaves, N.E. El-Gholl, 1985, **ATCC** 62616 (type culture); Minas Gerais, *Eucalyptus* sp., C.S. Hodges, 1974, **PPRI** 4742, **IMI** 354523; Minas Gerais, *Pteridium* sp., C.S. Hodges, 1974, **PPRI** 4743 **IMI** 354521; Minas Gerais, *Araucaria angustifolia*, C.S. Hodges, 1973, **PPRI** 4744 **IMI** 354520.
Notes: this species is morphologically similar to *C. ilicicola*. The two species have a similar vesicle, phialide and conidium morphology. In the original description of *C. spathulatum*, El-Gholl *et al.* (1986) compared this species with several *Cylindrocladium* spp. other than *C. ilicicola*. The original description also mentions that this species is homothallic, which is also true for *C. ilicicola*. Because of the similarities in their descriptions, Peerally (1991a) regarded the two species as synonyms.

In this study *C. spathulatum* and *C. ilicicola* are recognized as two distinct species. Conidia of *C. spathulatum* are 1-3-septate, (as *C. ilicicola*), but primarily 1-septate on CLA, and after 7 d hardly any 3-septate conidia can be found. *C. ilicicola*, however, has primarily 3-septate conidia on CLA. Furthermore, isolates of *C. spathulatum* can be distinguished from *C. ilicicola* by forming moderate, and not abundant chlamydospores, as is typical for *C. ilicicola*. *C. spathulatum* is also a low temperature species, as opposed to *C. ilicicola*, which is favoured by high temperatures. These species are clearly similar, but there is no justification in treating them as synonyms as proposed by Peerally (1991a). A recent study (Crous *et al.*, 1993b) also found the DNA banding patterns of *C. ilicicola* and *C. spathulatum* to be distinct.

El-Gholl *et al.* (1986) report asci to have 4-8 ascospores. This characteristic was observed in several collections, but in these cases asci were still immature. Mature asci of *Calonectria spathulata* had eight ascospores when grown on CLA.

22. **Cylindrocladium theae** (Petch) Subramanian, Hyphomycetes, an account of Indian species, except *Cercosporae*: 731 (1971).
Cercosporella theae Petch *Annals of the Royal Botanic Gardens of Peradeniya* **6:** 246 (1917).
Candelospora theae (Petch) Wakefield: Gadd *Monographs on Tea Production in Ceylon* **2:** 59 (1949).
Cylindrocladium theae (Petch) Alfieri & Sobers *Phytopathology* **62:** 650 (1972) (*nom. nud.*).
Holomorph: **Calonectria indusiata** Seaver *Mycologia* **20:** 58 (1928).
Calonectria theae Loos *Trans. Br. mycol. Soc.* **33:** 17 (1950).
Illustrations: Fig. 22; Loos (1950); Alfieri *et al.* (1972).
Descriptions: Petch, 1917; Loos (1950); Alfieri *et al.* (1972).

Macroconidiophores. *Stipe* septate, hyaline, terminating in a narrowly clavate vesicle, (3-)4(-6) μm diam.; stipes (340-)380(-600) μm long. *Conidiophore branches*: primary branches non-septate to 1-septate, (18-)26(-47) x (3-)4(-5) μm; secondary branches non-septate, (13-)19(-21) x (3-)4 μm; tertiary branches non-septate, (12-)16(-18) x 3(-4) μm; quaternary branches non-septate, (10-)14(-18) x 3(-4) μm. *Phialides* cylindrical to allantoid, hyaline, non-septate, (11-)13(-16) x (3-)4 μm. *Conidia* cylindrical, hyaline, (1-)3-septate, rounded at both ends, (65-)81(-96) x (5-)6(-7) μm. *Microconidiophores* unknown.

Cultural characteristics. *Temperature* min. above 10 C; max. below 35 C; opt. 25 C. This is a high temperature species, with only slight sporulation on aerial mycelium. *Colony colour* (reverse) 15'B ochraceous-buff (Rayner, 1970), 5B6 apricot (Kornerup & Wanscher, 1967). *Chlamydospores* extensive, arranged in fine chains, forming microsclerotia.

Teleomorph. *Perithecia* globose to ovoid, 220-500 x 220-480 μm, with warty outer wall and papillate ostiole, orange to red, turning blood-red in 3 % KOH. *Asci* hyaline, clavate, 80-145 x 16-26 μm, tapering to a long thin stalk, containing eight ascospores. *Ascospores* hyaline, straight or falcate, (1-)3-septate, not or slightly constricted at septa, (35-)53(-70) x (4-)7(-8) μm.

Type: Sri Lanka: *Camellia sinensis*, Loos, 1949, (Tea Res. Inst. Herb. No. 435) **IMI** 35027 (holotype of anamorph). **Trinidad:** leaf of a *Micropolis* sp., Seaver 3176, 13 Mar. 1921, (**NY**) (holotype of teleomorph).
Symptoms: leaf spots, defoliation, root rot, stem and petiole lesions (Peerally, 1974d; Mims *et al.*, 1981).

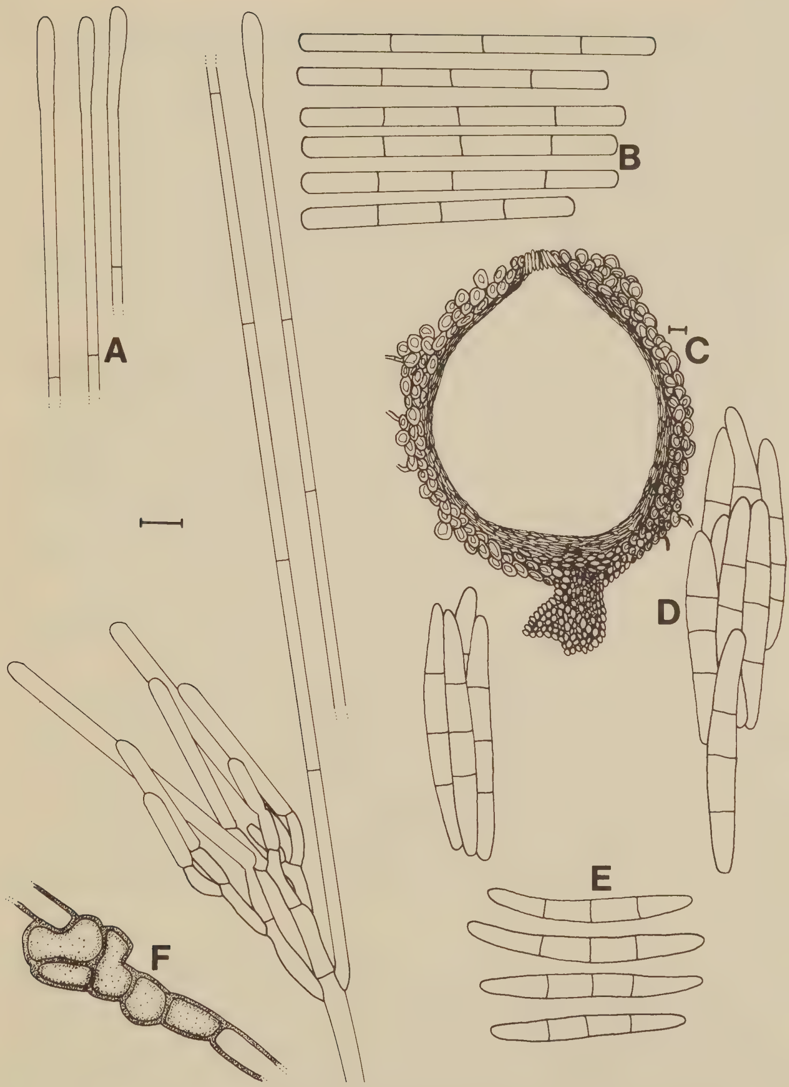


Fig. 22A-F. *Calonectria indusiata* and its *Cylindrocladium theae* anamorph. A, clavate vesicles, conidiophore and chlamydospores; B, conidia (**PPRI** 4188, bar = 10 μm); C, v.s. of a perithecium (bar = 20 μm); D, ascospores (**IMI** 146970); E, ascospores; F, chlamydospores (**PPRI** 4188, bar = 10 μm).

Hosts: *Acacia* spp., *Albizzia* sp., *Camellia sinensis*, *Eucalyptus* spp., *Micropolis* sp. and *Rhododendron* spp. (Subramanian, 1971; Peerally, 1974d; Mims *et al.*, 1981; El-Gholl *et al.*, 1983).
Distribution: Brazil, India, Sri Lanka, U.S.A. (Florida), Mauritius (Peerally, 1974d; Ferreira, 1989).
Specimens: India: *E. gigantea* Hook. f., Reddy, 1970, **IMI** 146970. **Trinidad:** a leaf of a *Micropolis* sp., Seaver 3176, 13 Mar. 1921, (**NY**). **Australia:** *Eucalyptus* sp., S. Hoone, (?), **IMI** 55858, 55859.
Cultures: USA: Florida, *Rhododendron* sp., N.E. El-Gholl, **ATCC** 48895: Florida, *Rhododendron* sp., N.E. El-Gholl (Viçosa, Brazil, **UFV** 16) **PPRI** 4188.
Notes: *C. theae* is characterized by having 3-septate conidia and clavate vesicles. Of the other 3-septate *Cylindrocladium* spp. with clavate vesicles, *C. theae* is very similar to *C. colhounii* var. *macroconidialis*. These two species have almost identical phialides and vesicles, but the stipes of *C. colhounii* var. *macroconidialis* are much shorter than those of *C. theae*. The teleomorph of *C. theae* also has red to red-brown perithecia with 8-spored asci, and not yellow perithecia with 4-spored asci like those of *C. colhounii* var. *macroconidialis*.

Calonectria indusiata was collected from a *Micropolis* leaf in Trinidad (Seaver, 1928). Ascospores were described as 55-80 x 7-8 μm in size and illustrated in the ascus as 3-septate. Although the illustration (Seaver, 1928) shows the ascospores as having very acute apices, they were found to be fusoid with rounded apices in this study. Ascospores (before discharge) in this collection were 3-septate, not constricted at septa, (35-)56(-70) x 6(-9) μm. Measurements of the asci, ascospores, as well as ascospore septation in young perithecia, indicate that this collection represents an earlier name for *Calonectria theae*. The name *Calonectria theae* is therefore reduced to synonymy with *Calonectria indusiata*.

23. **Cylindrocladium variabile** Crous, Janse, Victor, Marais & Alfenas *Syst. Appl. Microbiol.* **16**: 270 (1993).
Holomorph: **Calonectria variabilis** Crous, Janse, Victor, Marais & Alfenas *Syst. Appl. Microbiol.* **16**: 270 (1993).
Illustrations: Figs 23, 59, 60; Crous *et al.* (1993b).
Description: Crous *et al.* (1993b).

Macroconidiophores. *Stipe* septate, hyaline, terminating in a sphaeropedunculate or ellipsoid to clavate vesicle, (6-)9(-11) μm diam.; stipes (130-)180(-250) μm long. *Conidiophore branches*: primary

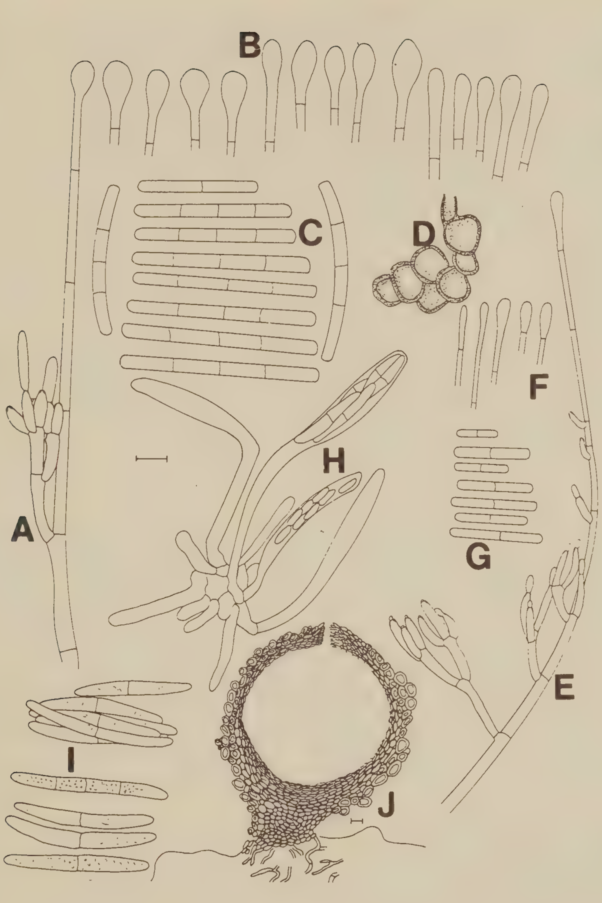


Fig. 23A-J. *Calonectria variabilis* and its anamorph *Cylindrocladium variabile* (PREM 51041) and its teleomorph (PREM 51039). A, macroconidiophore; B, sphaeropedunculate, ellipsoidal and clavate macrovesicles; C, cylindrical, straight or slightly curved (1-)3-septate macroconidia; D, chlamydospores; E, microconidiophore; F, clavate to ellipsoidal microvesicles; G, cylindrical 1-septate microconidia; H, developing asci with ascospores; I, immature guttulate, and mature, granular, 1-(3)-septate ascospores (**PREM** 51041, bar = 10 μm); J, v. s. through a perithecium (**PREM** 51039, bar = 20 μm).

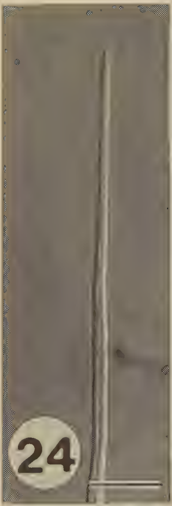
branches non-septate or rarely 1-septate, (15-)20(-30) x (3-)4(-5) μm; secondary branches non-septate, (10-)13(-18) x (3-)4(-5) μm; tertiary branches rare, non-septate, (8-)11(-14) x (3-)4(-5) μm. *Phialides* elongate, doliiform to reniform, hyaline, non-septate, (9-)13(-18) x (3-)4 μm. *Conidia* cylindrical, hyaline, (1-)3(-4)-septate, rounded at both ends, straight but frequently curved, widest in the middle of the lower cell, which prominently tapers towards the base, (48-)60(-75) x (4-)5(-6) μm.

Cultural characteristics. *Temperature* min. below 8 C; max. below 35 C; opt. 25 C. This is a eurythermal species, with medium sporulation on aerial mycelium. *Colony colour* (reverse) 13K amber brown (Rayner, 1970), 6D8 light brown (Kornerup & Wanscher, 1967). *Chlamydospores* extensive, forming microsclerotia throughout substratum.

Microconidiophores. *Stipe* septate, hyaline, terminating in a clavate to ellipsoid vesicle when present. *Conidiophore branches*: primary branches non-septate, (12-)15(-20) x (3-)4 μm; secondary branches non-septate, (9-)10(-12) x (2-)3(-4) μm. *Phialides* arising from the ends of branches, singly or in groups of 2-4, cylindrical, hyaline, non-septate, (9-)14(-17) x (3-)4 μm, collarettes absent. *Conidia* cylindrical, hyaline, 1-septate with obtuse ends, (12-)27(-36) x (3-)4 μm.

Teleomorph. *Perithecia* superficial on substrate, solitary or in groups of 2-3, globose to ovoid, 260-450 x 220-350 μm, with warty outer wall and papillate ostiole, red, turning blood-red in 3 % KOH; perithecial wall two-layered: outer region 35-60 μm wide, of elongate to angular cells (darkly pigmented), becoming globose at the surface (lighter pigmented), inner layer up to 20 μm wide, of hyaline, thin-walled, elongate cells; perithecial base 100-150 μm wide,

Figs 24, 25. *Calonectria avesiculata* (**ATCC** 38226). Fig. 24. Avesiculate stipe (bar = 10 μm). Fig. 25. V. s. of a perithecium (bar = 20 μm). Figs 26, 27. *Cylindrocladium candelabrum*. Fig. 26. Obpyriform vesicle. Fig. 27. One-septate conidium (**PPRI** 4162). Figs 28, 29. *Cylindrocladium citri* (**CBS** 186.36). Fig. 28. Spathulate vesicle. Fig. 29. Obovoid to pyriform vesicle. Figs 30-32. *Cylindrocladium clavatum* (**PPRI** 3997). Fig. 30. Clavate vesicle. Fig. 31. Conidiophore. Fig. 32. Conidia (bar = 10 μm).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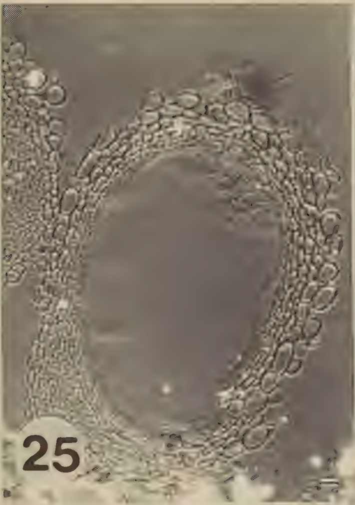
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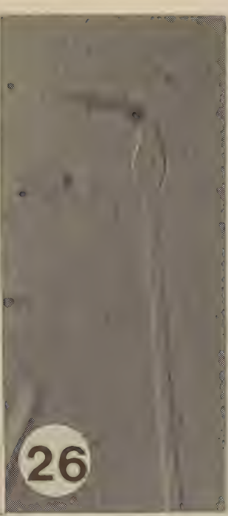
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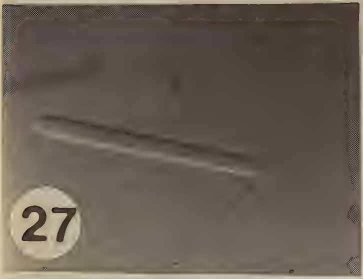
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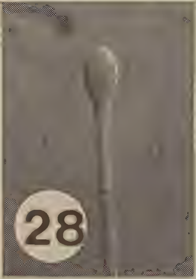
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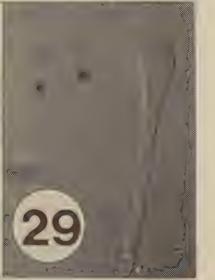
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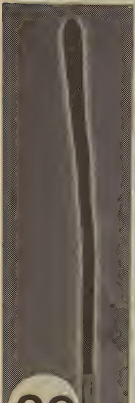
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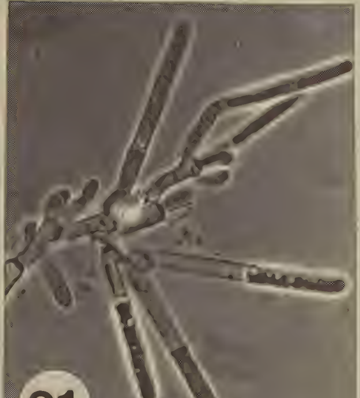
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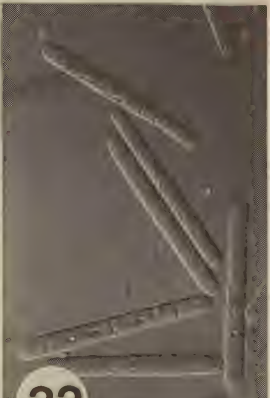
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consisting of angular cells, blackened around the point of attachment. *Asci* hyaline, clavate, 90-120 x 10-20 μm, tapering to a long thin stalk, containing eight ascospores. *Ascospores* hyaline, straight or falcate, 1(-3)-septate, not or slightly constricted at septa, guttulate when young, becoming granular at maturity, (34-)42(-60) x (4-)5(-6) μm.

Type: Brazil: Pará, near Belém, on *Didymopanax morototoni*, F. C. de Albuquerque, 1990, **PREM** 51039 (holotype of teleomorph); **PREM** 51041 (holotype of anamorph).
Symptoms: leaf spots (Crous *et al.*, 1993b).
Hosts: *Didymopanax morototoni*, *Eucalyptus* spp., *Theobroma grandiflora* (Crous *et al.*, 1993b).
Distribution: Brazil (El-Gholl, *et al.*, 1986).
Cultures: Brazil: Pará, near Belém, on *Didymopanax morototoni*, F. C. de Albuquerque, 1990, (Beltsville, Maryland, AR 2675), **PPRI** 4174, **CBS** 339.92, **IFO** 32466, **IMI** 354513 (type culture); Pará, near Belém, on *Theobroma grandiflora* K. Schum., F. C. de Albuquerque, 1990, (Beltsville, Maryland, AR 2676), **PPRI** 4175, **IMI** 354514; ES, Aracruz nursery, on *Eucalyptus* cuttings, A.C. Alfenas, **UFV** 123, **PPRI** 4741; Texeira de Freitas, large leaf spots on *Eucalyptus grandis* hybrid trees, Apr. 1993, P.W. Crous, **CPC** 593.
Notes: In a recent study *C. variabile* has been compared with morphologically similar species such as *C. citri*, *C. ilicicola*, *C. spathulatum* and *C. parasiticum* (Crous *et al.*, 1993b). *C. variabile* could easily be distinguished from the latter species by its esterase isozyme banding patterns and total DNA profiles, as well as vesicle and conidium morphology. The only species with a vesicle morphology similar to that of *C. variabile* is *C. parasiticum*. These two can, however, be distinguished by the range of variation found in the vesicle shape of *C. variabile*, which is not present in *C. parasiticum*, which has only sphaeropedunculate vesicles. All isolates thus far obtained of *C. variabile*

Figs 33-35. *Cylindrocladium colhounii* var. *macroconidialis* (**PPRI** 4000). Fig. 33. V. s. of a perithecium (bar = 20 μm). Fig. 34. Ascus with ascospores (bar = 10 μm). Fig. 35. Conidia. Fig. 36. Conidia of *Cylindrocladium colhounii* var. *colhounii* (**PPRI** 4183). Figs 37, 38. *Cylindrocladium parasiticum* (**CBS** 190.50). Fig. 37. Sphaeropedunculate vesicles. Fig. 38. Three-septate conidium. Figs 39, 40. *Calonectria kyotensis* (**PPRI** 4140). Fig. 39. Sphaeropedunculate vesicles. Fig. 40. Ascospores (bar = 10 μm).

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consistently produced a microconidial state. Although the macroconidia are primarily 3-septate, they are distinct from others having similar dimensions in that they are frequently slightly curved. Furthermore, conidia of *Cylindrocladium* spp. are often observed to develop a basal swelling with age. In *C. variabile*, however, the swelling is not at the base of the conidium, but slightly higher, giving the base a subtruncate appearance (Fig. 60).

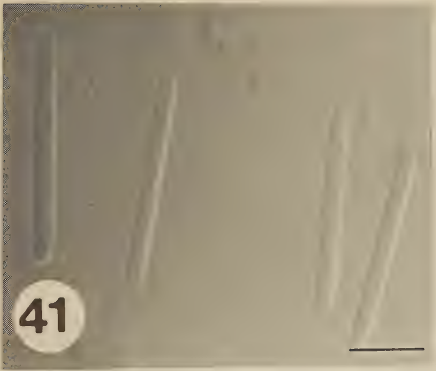
DOUBTFUL AND EXCLUDED SPECIES

Cylindrocladium avesiculatum var. **microsporae** Nair & Nair *Curr. Sci.* **52:** 1025 (1983).
This species is not validly published (Nair & Nair, 1983), since no type specimen was designated. Despite concerted efforts, no material of this species could be obtained.

Cylindrocladium couratarii Ram & Ram *Broteria* Ser 3, **41:** 90 (1972) (as *courватariae*).
In the original description (Ram & Ram, 1972), conidia are described as being cylindrical, 1-septate, 15-20 x 4-6 μm in size. The illustration shows them to be slightly attenuated at both ends, having 1-2 median septa (3 μm apart), with conidia being widest in the middle, unlike any *Cylindrocladium* sp. No stipes or vesicles are illustrated. A type culture (**ATCC** 24711) of *C. couratarii* has been examined, and it appears to be neither a *Cylindrocladium* nor a *Cylindrocladiella*, but rather a *Gliocephalotrichum* sp.

Cylindrocladium gregarium (Bres.) de Hoog *Persoonia* **10:** 73 (1978).
Diplocladium gregarium Bres. *Annls mycol.* **1:** 127 (1903).
Although the type specimen of this species has not been examined,

Figs 41-43. *Calonectria gracilis* (**PREM** 51031) (bar = 10 μm). Fig. 41. Conidia. Fig. 42. V. s. of a perithecium (bar = 20 μm). Fig. 43. Asci and ascospores. Fig. 44. Curved conidia of *Cylindrocladium hawksworthii* (**MUCL** 30866). Figs 45-48. *Cylindrocladium ilicicola* (**PPRI** 4151). Fig. 45. Three-septate macroconidium. Fig. 46. Microconidium. Fig. 47. Clavate vesicle. Fig. 48. Spathulate vesicle. Fig. 49. Ellipsoidal vesicle of *Cylindrocladium reteaudii* (**IMI** 39232). Fig. 50. Macroconidium and curved microconidia of *Cylindrocladium pteridis* (**IMI** 174348) (bar = 10 μm).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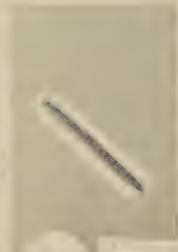
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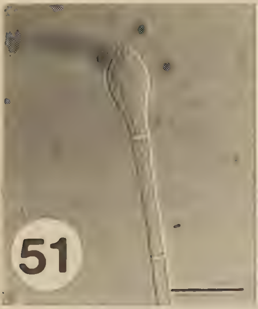
de Hoog's illustrations (de Hoog, 1978) show the conidia attenuated at their base, which is atypical of *Cylindrocladium* or *Cylindrocladiella*. The branching pattern also closely resembles that of *Leptographium* Lager. & Melin and *Phialocephala* Kendrick. It is thus doubtful that this collection is representative of either a *Cylindrocladium* or a *Cylindrocladiella* sp. The illustration shows a strong similarity with that of *Leptographium* spp.

Cylindrocladium intermedium Matsushima Microfungi of the Solomon Islands and Papua New Guinea. p. 18 (1971).
In the original description of *C. intermedium*, Matsushima (1971) mentions that conidia are produced in yellow to hyaline conidial masses. This, together with the very uniformly cylindrical conidia, branch development, and the absence of a stipe suggests that *C. intermedium* would be better accommodated in the genus *Gliocladiopsis* Saksena (Saksena, 1954; Crous & Wingfield, 1993). It has thus far not been possible to obtain the type specimen of this species, which is lodged in Matsushima's own herbarium (**MFC** 2678).

Cylindrocladium terrestre Roy & Dwivedi *Proc. 56th Indian Sci. Congr.* **3:** 308 (1969) (*Index of Fungi* **4(8):** 242).
It has not been possible to locate the proceedings in which this species was described (Roy & Dwivedi, 1969). This species was, however, not validly published because it lacked a Latin diagnosis.

Nectria leguminum Rehm *Hedwigia* **39:** 221 (1900).
N. leguminum was treated by Rossman (1983) as a synonym of *Calonectria pyrochroa*. An examination of the type specimen lodged at **S** showed a *Cylindrocladium* sp. with 5-septate conidia to be present. The *Cylindrocladium* anamorph of *Calonectria pyrochroa* never has this number of conidial septa, but rather has (1-)3-septate conidia. For this reason it is not possible to concur with Rossman's treatment of this

Figs 51-54. *Calonectria morganii* (**PREM** 51042) (bar = 10 μm). Figs 51-53. Ellipsoidal to obovoid or pyriform vesicles. Fig. 54. Asci with ascospores. Figs 55, 56. *Cylindrocladium spathiphylli* (**ATCC** 44730). Fig. 55. Conidiophore. Fig. 56. Globose vesicle. Fig. 57. Conidiophore with conidia and naviculate vesicle of *Cylindrocladium naviculatum* (**CPC** 627). Fig. 58. Ovoid vesicles of *Cylindrocladium ovatum* (**UFV** 89). Figs 59, 60. *Cylindrocladium variabile* (**PPRI** 4147). Fig. 59. Microconidiophore. Fig. 60. Three-septate conidium.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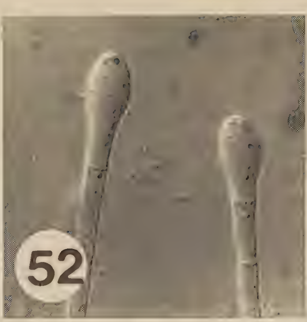
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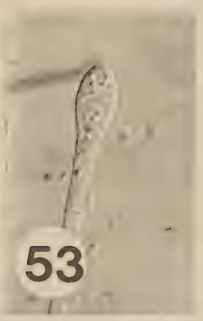
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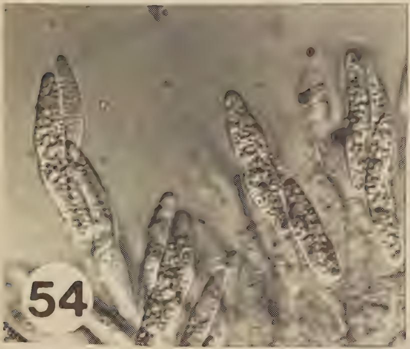
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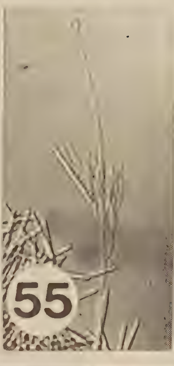
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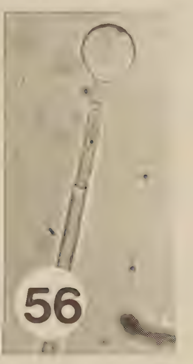
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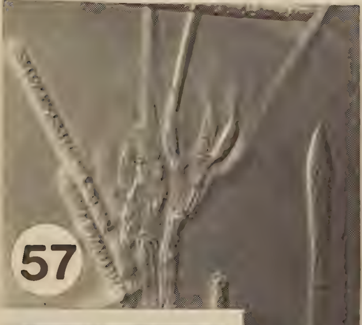
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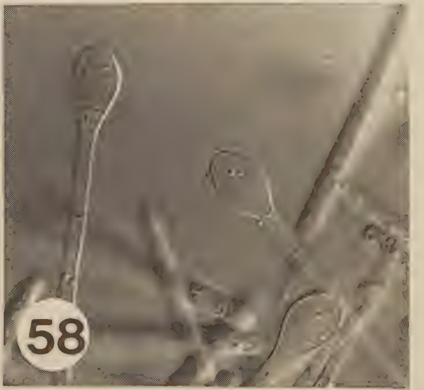
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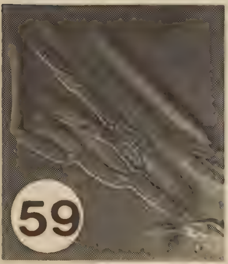
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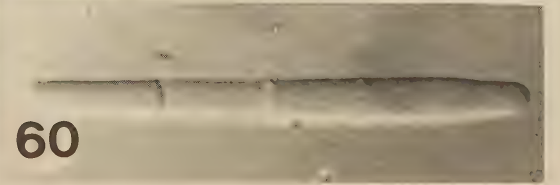
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species, and we are of opinion that it represents an undescribed *Cylindrocladium* anamorph. Because the conidia on the type specimen of *N. leguminum* are 5-septate, this collection might be confused with *Calonectria quinqueseptata*. However, there are two reasons why this collection cannot be identified as *C. quinqueseptata*. Firstly, the ascospores are 1-septate, and much smaller (31-50 x 4-6) than the larger, 3-septate ascospores characteristic of *C. quinqueseptata*. Secondly, conidia were (1-)3(-6)-septate, 45-61 x 5-6 μm in size, much smaller than those of *Cylindrocladium quinqueseptatum*, which are (1-)5-septate. *N. leguminum* is, therefore, not regarded as conspecific with either *Calonectria pyrochroa* or *C. quinqueseptata*. It is however probable that this collection represents an as yet undescribed *Cylindrocladium* and *Calonectria* sp. Further collections are required to sufficiently describe this holomorph as new.

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MYCOTAXON

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A CHECK-LIST OF RHIZOCTONIA EPITHETS

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SUMMARY

Only seven taxa are considered to be validly published, recognizable and referable to *Rhizoctonia* DC. s.l. They are all referable to the four genera considered by Moore (1987). The list includes 119 epithets at species or subspecies level described in *Rhizoctonia*. Of these 48 are nomina nuda or provisional names, 30 are excluded from *Rhizoctonia*, 9 are considered to be doubtful taxa due to poor descriptions, 1 is synonymous with *Rhizoctonia oryzae-sativae*, 7 are synonymous with *Rhizoctonia crocorum*, and 17 are synonymous with *Rhizoctonia solani*. This paper demonstrates the necessity to follow the rules of the ICBN, and should facilitate taxonomical work with *Rhizoctonia* in the future.

INTRODUCTION

The form genus *Rhizoctonia* DC. is of considerable economical importance, since it includes pathogens on various crops, such as *Crocus* and *Medicago* (DeCandolle 1815), *Solanum* (Kühn 1858), *Zea* (Voorhees 1934), *Oryza* (Ryker & Gooch 1938), and cereals (Boerema & Verhoeven 1977). Furthermore, *Rhizoctonia* spp. occur as endophytes in many orchids (Bernard 1909, Burgeff 1932, 1936, Hadley 1969, Warcup & Talbot 1966, 1980, Warcup 1970, 1981). The considerable interest in this form genus has resulted in the publication of a very large number of epithets. Many of these are, however, results of immediate local needs for reference frames established by non-taxonomists. Very few attempts have been made to clarify the specific delimitations in *Rhizoctonia*, Duggar (1915), Parmeter & Whitney (1970) and Sneh, et al. (1991) being prominent exceptions, and taxonomy of the form genus has proved difficult to handle considering traditional morphological characters only.

Since the inconspicuous hymenial structures are rarely produced in culture and rarely observed on the host, the taxonomy of the anamorphs was correlated with teleomorph characters relatively late (Donk 1966, Warcup & Talbot 1966, 1980, Talbot 1965, 1970, Warcup 1970, 1981). However, in the last three decades modern techniques such as ultrastructure of the septal pore (Moore & McAlear 1962, Tu & Kimbrough 1975, 1978, Moore 1978, Patton & Marchant 1978, Khan & Kimbrough 1982, Oberwinkler & Bandoni 1982) and enzymatic activity (Sweetingham et al. 1986, Mordue et al. 1989, Cruickshank 1990) have increased the possibility of anamorph recognition. As a consequence, the form genus *Rhizoctonia* s.l. has been divided into genera correlated with their teleomorphs: *Rhizoctonia* (*Helicobasidium*), *Moniliopsis* (*Thanatephorus* and *Waitea*), *Ceratorhiza* (*Ceratobasidium*), and *Epulorhiza* (*Tulasnella* and *Sebacina*) (Moore 1987). The form genus *Ascorhizoctonia* is not considered to belong to *Rhizoctonia* s.l.. It is treated in sufficient detail elsewhere (Yang & Korf 1985).

The taxonomical rationale behind the erection of new genera is not disputed, as it is a consequence of the correlation to teleomorphs, and may resolve the problems expressed by Parmeter (1965). However, as the segregation is based on pore ultrastructure and number of nuclei, only living cultures can be referred to form genus with certainty. The choice of correct names for species following the rules of the ICBN (Greuter 1988) is still dependent on descriptions based on traditional characters, such as hyphae, monilioid cells, sclerotia, host plant etc., of which some are of doubtful taxonomical value in *Rhizoctonia* s.l. (Andersen 1990). DeCandolle (1815) emphasized two characters in *Rhizoctonia*: the ability to infect living plants, and the production of sclerotia different from those of *Sclerotium*. Furthermore, the mycelium is sterile. These are the only morphological criteria which can be considered to delimit *Rhizoctonia* s.l. as a group.

The purpose of this study is to facilitate a modern taxonomical treatment of *Rhizoctonia* s.l. by compiling all epithets published in *Rhizoctonia* up to today. Based on a careful evaluation of all available authentic material, such as protologue, type specimen and living culture, the taxonomical and nomenclatural status of the epithets is noted together with annotations. Taxa which do not belong to *Rhizoctonia* s.l. are referred to their proper place whenever possible, and the remainder are excluded from *Rhizoctonia* s.l.

A recent publication concerned with the identification of *Rhizoctonia* species (Sneh et al. 1991) does also contain a short taxonomical survey of the form genus. It appears to be based on earlier published material, since it repeats some earlier errors, and does not contain bibliography, original investigations or other arguments for decisions. For the practical approach to identification this book is a valuable tool, but for the proper use of names in accordance with the ICBN and for synonymity, a comparison with the present paper should be made.

MATERIALS AND METHODS

A search for herbarium material, especially type specimens, was carried out. The specimens obtained were matched with descriptions and their identity was determined. The identification was based on observations of general appearance, hyphal morphology, and sclerotial structure. General appearance was viewed in a Wild Macroscope or Olympus S2 III Macroscope at 20X-32X magnification. Special attention was placed on the occurrence of sclerotia and aerial hyphae. Sections of surface tissue and sclerotia were prepared after rehydration of small pieces of tissue in 40% ethanol solution or in a 5% KOH solution. The sections were viewed unstained in a microscope at 250X-1000X magnification, to observe infection pattern and sclerotial structure.

CHECK-LIST OF EPITHETS

aderholdii (Ruhland) Marchionatto 1946 - Rev.Fac. Agron. La Plata 26, p.4. (as "adheroldii")
Moniliopsis aderholdii Ruhland 1908 - Arb. kaiserl. biol. Anst.Land- u. Forstwirtsch. 6, p.76.

Type not extant. In *Asparagus officinalis*. The description points towards *Rhizoctonia (Moniliopsis) solani*, as also stated by Duggar (1915, 1916) and Moore (1987). It is regarded as a synonym of *M. solani* (Kühn) Moore.

aerea Burgeff 1932 - Saprophytismus und Symbiose, Studien an tropischen Orchideen, p.152.

Doubtful taxon (type not extant, no illustration, art. 9.3 ICBN). Endophyte in roots of *Taeniophyllum glandulosum*. The description is scanty, but the curved, horn-shaped sclerotial hyphae are unusual.

alba Matz 1921 - J. Dep. Agric. Porto Rico 5, p.29.
Doubtful taxon. Type not extant. In leaves of *Apium* sp. The description is not sufficiently detailed to make a positive identification.

allii Graves apud Duby 1830 - Botanicon Gallicum, ed. II, p.867.
Type not extant, no illustration. In *Allium ascalonicum*. Cited as "Graves in litt." but no publication or type from Graves could be traced. It is considered to be *Rhizoctonia crocorum*.

alpina E. Castellani 1935 - Annali R. Ist. sup. agr. for. naz., Ser. 2a, 5, p.71.
Nomen invalidum (no latin diagnosis, art. 36). In roots of *Viola palustris*. An authentic strain, CBS 309.35, is uninucleate and has dolipores (Burpee et al. 1980).

anaticula Currah 1987 - Can. J. Bot 65, p.2474.
Epulorhiza anaticula (Currah) Currah 1990 in Currah et al. - Can. J. Bot. 68, p.1174.
Type in UAMH: no. 5434. Endophyte in roots of *Platanthera obtusata*. The taxon is well described and is distinct. The strain UAMH 5428, referred to *Rhizoctonia anaticula* by Currah et al. (1987), has imperforate parenthesomes, which confirms its assignment to *Epulorhiza*.

anomala Burgeff 1936 -Samenkeimung der Orchideen und Entwicklung ihrer Keimpflanzen, p.132.
Moniliopsis anomala Burgeff ex Currah 1990 in Currah et al. - Can. J. Bot. 68, p. 1180.
Nomen invalidum (no latin diagnosis, art. 36). Endophyte in roots of *Orchis (Dactylorhiza) maculata*. Validated, redescribed and neotypified by Currah in Currah et al. (1990). **Neotype** in UAMH: no. 6451. Endophyte in *Coeloglossum viride*.

apocynacearum Demeter 1923 - Flora (Jena) 116, p.437.
Nomen invalidum (provisional name, art. 34). In roots of *Vinca minor*. The description gives no diagnostic characters for identification.

arachnion Burgeff 1932 - Saprophytismus und Symbiose, Studien an tropischen Orchideen, p.151.
Doubtful taxon (type not extant, no illustration, art. 9.3). Endophyte in roots of *Thrixspermum arachnites*. The description is scanty and no positive identification is possible.

asclerotica Burgeff 1936 - Samenkeimung der Orchideen und Entwicklung ihrer Keimpflanzen, p.130.
Nomen invalidum (no latin diagnosis, art. 36). Type and authentic culture not extant. Endophyte in roots of *Ophrys apifera*. The description does not allow a positive identification, as the taxon is based mainly on the absence of sclerotia.

asparagi Fuckel ex Erikss. 1915 - Arkiv f. Bot. 14(12), p.16.
Rhizoctonia asparagi Fuckel [non Fr.] 1869 - Symbolae mycologicae, p.406. (Nomen invalidum).
Type not extant. In *Asparagus officinalis*. Originally published by Fuckel (1869) only with notes regarding host, but with a reference to Fries (1823). However, Fries only mentioned the occurrence of *Rhizoctonia* on *Asparagus*, but did not describe a new species. Eriksson (1915) described *R. asparagi* Fuckel in detail. Donk (1966) considered this as a valid publication of *R. asparagi* Fuckel ex Erikss. *R. asparagi* is however considered to be a synonym of *R. crocorum*, with the additional comment, that the serious infectional pattern described by Eriksson may be caused by a simul-

taneous infection of *Fusarium oxysporum*, as described by Stahl (1970).

aurantiaca Ellis & Everh. 1884 - Bull. Torrey bot. Club 11, p.17.
Doubtful taxon (type not extant, no illustration, art. 9.3). On bark of decaying branch of *Acer* sp. The characters do not conform with the circumscription of *Rhizoctonia* s.l.

batatas Schw. apud. Fr. 1828 - Elench. Fung. 2, p.45.
R. batatas Schw. 1832 - Trans. Amer. phil. Soc. 4, p.264.
Doubtful taxon (type not extant, no illustration, art. 9.3). In tubers of *Convolvulus (Ipomoea) batatas*. Fries referred to *Thanatophytum batatas* Schw. ined. and considered it as related to, but strongly different from *R. crocorum*. Schweinitz (1832) did correct the generic name before publication, but the characters do not conform with the circumscription of *Rhizoctonia* s.l.

bataticola (Taubenhaus) Butler apud Briton-Jones 1925 - Bull. Minist. Agric. Egypt 49, bot. Sect., p.65.
Sclerotium bataticola Taubenhaus 1913 - Phytopathology 3, p.161.
The type specimen (*Sclerotium bataticola* Taub., BPI no. 1586) is identified as the anamorph of *Tiarosporella phaseolina* (Tassi) v.d.Aa. In *Ipomoea batatas*.

betae Eidam in Cohn 1888 - Jahresber. Schles. Gesell. vaterl. Kultur 1887, p.261.
Type not extant, no illustration. In roots of *Beta vulgaris*. Eidam (1888) refers to *R. betae* Kühn, citing a paper called "Die Krankheitserscheinungen der Kulturgewächse" p. 232. We believe it to be a miscitation of Kühn (1858), since this particular page describes a "Runkelrübenkrankheit". *R. betae* is not mentioned, and Eidam is to be credited for this name. It is considered to be *Rhizoctonia (Moniliopsis) solani* which is also suggested by Kühn (1858), Duggar (1915) and Parmeter and Whitney (1970). "Rhizoctonia betae Cohn 1853 - Jahresber. Schles. Gesell. vaterl. Kultur, p.98", cited in Oudemans (1920) is probably an error due to a misreading of Eidam. No name was used by Cohn (1853).

bicolor Ellis 1883 - North Am. Fungi, Ser.I, no. 977.
Nomen invalidum according to Stevenson (1971), since it only appears as a name on a herbarium sheet (art. 32.1). The type specimen in L: no. 910.246-1404 contains a sterile *Hypoxylon*-like structure with a dark brown crust and ochraceous medulla. On bark of *Pinus emortuus*.

borealis J.T. Curtis 1939 - Amer. J. Bot. 26, p.393.
Nomen invalidum (no latin diagnosis, art. 36). Endophyte in *Goodyera repens var. ophioides*. It is considered to be *Rhizoctonia (Moniliopsis) solani*.

brassicarum Libert 1834 - Crypt. Ard. no. 240.
A type specimen could not be located and its identity is therefore unknown. In roots of *Brassica oleracea*. It is treated as a doubtful taxon.

callae E. Castellani 1935 - Annali R. Ist. sup. agr. for. naz., Ser. 2a, 5, p.73.
Nomen invalidum (no latin diagnosis, art. 36). In roots of *Calla aethiopica*. An authentic strain, CBS 310.35, is binucleate and has simple septa (Burpee et al. 1980).

candida Yamamoto 1962 - Trans. mycol. Soc. Japan 3, p.120.
Nomen invalidum (no holotype is specified, art. 37). In roots of *Fragaria grandiflora*. Ogoshi et al. (1979) refer it to *Ceratobasidium cornigerum* AG-A, but no authentic material was used in their investigation.

carnea Ellis & Everh. 1886 - J. Mycol. 2, p.39.
Doubtful taxon (type not extant, no illustration, art. 9.3). On decaying chips (of

wood). The sclerotia described by Ellis & Everhardt (1886) do not conform with those found in *Rhizoctonia* s.l. Therefore, this taxon is excluded from *Rhizoctonia*.

carotae Rader 1948 - Phytopathology 38, p.444.
Type specimen in CUP: no. 37972. In root of *Daucus carotae*. The characteristics of the type specimen and the type strain, CBS 464.48, indicate a close relationship to *Sclerotium rolfsii*, not to *Rhizoctonia* s.l.

cavendishiani Burgeff fide Sneh, Burpee & Ogoshi 1991 - Identification of Rhizoctonia species. APS Press, p.74.
Nomen invalidum (provisional name, art. 34). Burgeff never published the name in *Rhizoctonia*, but he mentioned a M.R. (Mycelium radices) cavendishiani which he specifically stated was of provisional character (Burgeff 1911).

centrifuga Lév. 1843 - Ann. Sci. nat. Bot., Sér. II, 20, p.225.
A sclerotium producing parasite on lichens. Jülich (1972) examined the type specimen (G) which contains a sterile athelioid fungus. The description suggests the anamorph of *Athelia arachnoidea*. This taxon does not belong to *Rhizoctonia* s.l.

cerealis Van der Hoeven in Boerema and Van der Hoeven 1977 -Neth. J. Plant Path. 83, p.191.
Ceratorhiza cerealis (Van der Hoeven) Moore 1987 - Mycotaxon 29, p.94. (nomen invalidum)
Nomen invalidum (no holotype specified, art. 37). Type not extant (the "type" mentioned in the protologue refers to a strain at the CBS). In *Secale cereale*, causing sharp eyespot disease in grasses. The authentic strain, CBS 236.77, can be referred to *Ceratorhiza*, and belongs to CAG-1 in the *Ceratobasidium cornigerum* complex, which is also known as *C. cereale* Murray & Burpee.

choussii Crandall & Arillaga 1955 - Mycologia 47, p.404.
Contrary to statements in the protologue, no type specimen is present in BPI and no strains have been deposited in ATCC or CBS. In roots and stembase of *Coffea arabica*. It is regarded as conspecific with *Rhizoctonia (Moniliopsis) solani*. Two orthographic errors, *R. chuosii* and *R. chpisoo*, occur in Sneh et al. (1991).

coniothecioides Sappa & Mosca 1954 - Allionia 2, p.226.
Doubtful taxon. Type not extant. In soil. The description suggests an ascomycetous affinity, and does not conform with the circumscription of *Rhizoctonia* s.l.

crocorum (Pers.:Fr.) D.C. 1815 - Flore Française, ed. 3, vol. V, p.111.
Sclerotium crocorum Pers. 1801 - Syn. meth. Fung., p.119.
Type in L: Herb. Persoon, *Sclerotium crocorum*. Parasitic in *Crocus sativa*. *R. crocorum* is the type species of *Rhizoctonia*. The teleomorph of *R. crocorum* is *Helicobasidium purpureum* Pat. Donk (1958) considered *H. brebissonii* (Desm.) Donk as the correct name, but nothing in Desmazière's protologue of *Protonema brebissonii* indicates, that he was actually dealing with a teleomorph. Consequently, *P. brebissonii* Desm. is considered as a synonym of *R. crocorum*.

dauci Rabenh. 1855 - Kl II: no. 74.
Type in L: Rabenhorst Kl I no. 1970. In *Daucus carotae*. A name change for *Helminthosporium rhizoctonon* Rabenh. based on material from Kühn. *H. rhizoctonon* is later by Kühn (1858) recognized as a synonym for *Rhizoctonia medicaginis* DC. ex Fr. Both the type and Rabenhorst Kl II no. 74 are identified as *R. crocorum*.

destruens F. Tassi 1900 - Bull. Lab. Ort. bot. Siena 3, p.50.
Type not extant. In roots of *Delphinium*, *Lobelia* and *Hibiscus*. Based on the

protologue *R. destruens* seems to be a *Sclerotium* sp. and does not belong to *Rhizoctonia* s.l.

dichotoma Saksena & Vaartaja 1960 - Can. J. Bot. 38, p.934.
Nomen invalidum (no holotype specified, art. 9.5 and art. 37). Type not extant. In seedlings of *Picea pungens*. Saksena & Vaartaja (1960) deposited no type specimens (Ginns 1983, Yang & Korf 1985, Moore 1987), but their "types" were living cultures. Parmeter and Whitney (1970) consider it a synonym of *Rhizoctonia (Moniliopsis) solani*. An authentic strain, DAOM 138187, is *Rhizoctonia (Moniliopsis) solani*.

dimorpha Matz 1921 - J. Dep. Agric. Porto Rico 5, p.20.
Type not extant, no cultures deposited. In stems, leaves and pods of *Phaseolus*. From the protologue it is considered to be synonymous with *Rhizoctonia (Moniliopsis) solani*, as also suggested by Parmeter and Whitney (1970).

endophytica var. **endophytica** Saksena & Vaartaja 1960 - Can. J. Bot. 38, p.936.
Nomen invalidum (no holotype specified, art. 9.5 and art. 37). Type not extant. In seedlings of *Pinus banksiana*. An authentic strain ATCC 14013 (CBS 257.60) has probably affinity towards *Ceratorhiza*, but it did not anastomose with any binucleate strain in an investigation by Burpee et al. (1980).

endophytica var. **filicata** Saksena & Vaartaja 1960 - Can. J. Bot. 38, p.938.
Nomen invalidum (no holotype specified, art. 9.5 and art. 37). Type not extant. In seedlings of *Pinus banksiana*. An authentic strain, CBS 261.60 (= ATCC 14014), is referred to *Waitea circinata* (Oniki et al. 1985).

ferrugena Matz 1921 - J. Dep. Agric. Porto Rico 5, p.28.
Type not extant. In diseased roots of sugar cane. It is considered to be synonymous with *Rhizoctonia (Moniliopsis) solani*.

floccosa Burgeff 1932 - Saprophytismus und Symbiose, Studien an tropischen Orchideen, p.152.
Doubtful taxon (type not extant, no illustration, art. 9.3). Endophyte in roots of *Myrmechis glabra*. An authentic strain, CBS 336.36, is binucleate and has dolipores (Burpee et al. 1980). The very small monilioid cells are quite distinct.

fragariae Husain & McKeen 1963 - Phytopathology 53, p.533.
Ceratorhiza fragaria (Husain & McKeen) Moore 1987 - Mycotaxon 29, p.94. (nomen invalidum)
Nomen invalidum (no holotype specified, art. 37). Type not extant. In roots, petioles, stolons and fruits of *Fragaria ananassa*. An authentic strain, CBS 335.62 (=ATCC 14691), is binucleate with dolipores and is placed in anastomosis group CAG-2 of *Ceratobasidium cornigerum* (Burpee et al. 1980).

fraxini E. Castellani 1935 - Annali R. Ist. sup. agr. for. naz., Ser 2a, 5, p.70.
Nomen invalidum (no latin diagnosis, art. 36). In *Fraxinus*. An authentic strain, CBS 311.35, is binucleate (Parmeter et al. 1967), and has dolipores (Burpee et al. 1980).

fuccosa Sneh, Burpee & Ogoshi 1991 - Identification of Rhizoctonia species. APS Press, p.119.
Nomen invalidum (no latin diagnosis, art. 36, no holotype specified, art. 37). Burgeff never published this name, and it must be ascribed solely to Sneh et al (1991). It may be an orthographical error of *R. floccosa* Burgeff.

fuliginea Sappa & Mosca 1954 - Allionia 2, p.227.
Doubtful taxon. Type not extant. In forest soil. The protologue suggests a species

with ascomycetous affinity, and not belonging to *Rhizoctonia* s.l.

fumigata (Nakata ex Hara) Gunnel & Webster 1987 - Mycologia 79, p.735.
Sclerotium fumigatum Nakata ex Hara 1930 - Path. Agricult. Plant., p.168.
Type in UC: no. 1475045, dried material of CBS 577.81. In *Oryza*. This taxon is considered to be a synonym of *Rhizoctonia (Ceratorhiza) oryzae-sativae* (Moore 1989).

fusca Rostrup 1893 - Sygdomme hos landbrugsplanter foraarsagede af snyltesvampe, p.125.
Lectotype (selected here) in C: E. Rostrups Svampesamling, Sj. Vejenbrød 11/4 1892. This is selected as the lectotype from the six specimens deposited by Rostrup. In turnips (*Brassica napus*). The six specimens were all *Rhizoctonia (Moniliopsis) solani*.

globularis Saksena & Vaartaja 1960 - Can. J. Bot. 38, p.939.
Nomen invalidum (no holotype specified, art. 9.5 and art. 37). Type not extant. In rootlets of seedlings of *Pinus banksiana*. According to Warcup and Talbot (1966) the authentic strain (CBS 262.60, H.K.Saksena 2287) is *Sebacina* sp., and an additional strain, H.K.Saksena 2616, cited by Saksena & Vaartaja (1960) as a paratype, is not conspecific, but was a *Ceratobasidium cornigerum*. Following this, *R. globularis* is regarded as a nomen ambiguum (see also Ginns 1983).

goodyerae-repentis Costantin & Dufour 1920 - Rev. Gen. Bot. 32, p.532.
Ceratorhiza goodyerae-repentis (Costantin & Dufour) Moore 1987 - Mycotaxon 29, p.94. (author of the basionym cited as "Constantin").
Doubtful taxon (type not extant, no illustration, art. 9.3). Authentic strains not extant. Endophyte in roots of *Goodyera repens*. The description does not provide sufficient information to secure a positive identification. Although specificity between orchid and fungus has never been proven, many strains from *Goodyera repens* have been given this name (Downie 1941, Hadley 1969). Comparison of the data from Downie (1941) with the original description shows almost no overlap of measurements. Hence *Rhizoctonia (Ceratorhiza) goodyerae-repentis* as an anamorph of *Ceratobasidium cornigerum*, first suggested by Warcup & Talbot (1966), must be doubted, since it was based on isolate "Rgr" from Hadley, identified according to the concept of Downie (Hadley 1969).

gossypii var. **gossypii** Forsteneichner 1931 - Phytopath. Z. 3, p.385.
Rhizoctonia gossypii var. *anatolica* Forsteneichner 1931 - Phytopath. Z. 3, p.385. (Selected as autonym.)
Type not extant. In *Gossypium*. Forsteneichner (1931) neglected to establish an autonym of the new species, and since he works with two strains only, one of these, *R. gossypii* var. *anatolica* is selected as autonym because it is the first variety mentioned in the protologue. It is considered to be a synonym of *Rhizoctonia (Moniliopsis) solani*.

gossypii var. **aegyptiaca** Forsteneichner 1931 - Phytopath. Z. 3, p.386.
Type not extant. In *Gossypium*. The causal agent of sore-shin disease. As suggested by Parmeter and Whitney (1970), it is considered to be a synonym of *Rhizoctonia (Moniliopsis) solani*.

gracilis Burgeff 1936 - Samenkeimung der Orchideen und Entwicklung ihrer Keimpflanzen, p.136.
Nomen invalidum (no latin diagnosis, art. 36). Type not extant. Endophyte in roots of *Oncidium* spp. The description does not allow a positive identification.

grisea (Stevenson) Matz 1920 - J. Dep. Agric. Porto Rico, 4, p.40.
Sclerotium griseum Stevenson 1917 - Ann. Rep. insular Exp. Sta., p.138.
In sugar cane. None of Stevenson's collections were available from Puerto Rico. However, Matz compared his specimens with herbarium material from Stevenson. Based on the protologue and the description by Matz it is considered to be synonymous with *Rhizoctonia (Moniliopsis) solani*.

hiemalis Saksena & Vaartaja 1960 - Can. J. Bot. 38, p.940.
Ascorhizoctonia hiemalis Yang & Korf 1985 - Mycotaxon 23, p.473.
Nomen invalidum (no holotype specified, art. 37). Validated by Yang and Korf (1985), **Neotype** in CUP: no. 61622. In pine litter under *Pinus silvestris*. The teleomorph is *Tricharina hiemalis* Yang & Korf (1985).

himantia Schw. 1832 - Trans. Amer. phil. Soc. 4, p.264.
Doubtful taxon (type not extant, no illustration, art. 9.3). In roots and bulbs of *Iris* sp. The description does not support a retention in *Rhizoctonia* s.l. The author suggested it could be a juvenile form of *R. radiciformis*, which was equally misplaced in *Rhizoctonia* s.l.

juniperi Lihnell 1939 - Symb. bot. Upsaliens. 3, p.102.
Nomen invalidum (no latin diagnosis, art. 36). Type not extant. In *Juniperus communis*. The description suggest an ascomycetous affinity, not belonging to *Rhizoctonia* s.l.

lamellifera Small 1924 - Trans. Brit. mycol. Soc. 9, p.152.
Type not extant. In roots of *Grevillea robusta*. A synonym of *Sclerotium bataticola* Taub. according to Ashby (1927), which is synonymous with the anamorph of *Thiarosporella phaseolina* (Tassi) v.d.Aa. The description likewise suggests ascomycetous affinity. It does not belong to *Rhizoctonia* s.l.

lanuginosa Bernard 1909 - Ann. Sci. Nat. Bot., ser. IX, p.34.
Doubtful taxon. Type not extant. Endophyte in roots of *Odontoglossum* sp. The protologue does not provide sufficient information for an identification.

leguminicola Gough & E.S. Elliott 1956 - Bull. W. Virg. Exp. Sta. 387 T, p.16.
Type in BPI: no. USO 455779 (E.S.Elliott no. 1580). On *Trifolium pratense* causing blackpatch. The description matches *Botrytis*, and the type of *R. leguminicola* is most probably *B. fabae* Sardina.

lilacina Sappa & Mosca 1954 - Allionia 2, p.184.
Doubtful taxon. Type not extant. From forest soil. The description suggests an ascomycetous affinity, and it does not belong to *Rhizoctonia* s.l.

lupini E. Castellani 1935 - Annali R. Ist. sup. agr. for. naz., Ser. 2a, 5, p.70.
Nomen invalidum (no latin diagnosis, art. 36). Type not extant. In roots of *Lupinus albus*. As suggested by Parmeter and Whitney (1970), it is considered to be *Rhizoctonia (Moniliopsis) solani*.

macrosclerotia Matz 1921 - J. Dep. Agric. Porto Rico 5, p.19.
Type not extant. In petioles and stems of *Phaseolus* sp. It is considered to be conspecific with *Rhizoctonia (Moniliopsis) solani*, as also suggested by Parmeter and Whitney (1970).

mali DC. 1815 - Mem. Mus. Hist. nat. 2, p.216. (as ?mali).
Doubtful taxon (type not extant, no illustration, art. 9.3). From roots of *Malus*. The description is too scanty for any suggestion of identity. Fries (1823) places it in "species ignota".

medicaginis DC 1815 - Flore Française, ed. 3, vol. V, p.111.
Type in G: no. GCK 1649, Herbier De Candolle. In *Medicago sativa*. The type specimen contains *R. crocorum*, as earlier suggested by Tulasne & C. Tulasne (1862) and Donk (1966).

melongenae Matz 1921 - J. Dep. Agric. Porto Rico 5, p.29. (as "melongena").
Type not extant. In decaying *Solanum melongena*. Based on the protologue it is considered to be a synonym of *Rhizoctonia (Moniliopsis) solani*, a conclusion earlier reached by Parmeter and Whitney (1970) and also suggested by Matz (1921), who only distinguished it by the choice of host.

menthae Berk. & Broome 1861 - Ann. Mag. nat. Hist. Ser. 3, 7, p.17.
Type not extant. In stems of *Mentha*, just above the soil. Buddin and Wakefield (1927) identified it as the *Tuberculina* state of *Puccinia menthae*. Based on the description it does not belong to *Rhizoctonia* s.l.

microsclerotia Matz 1917 - Phytopathology 7, p.117.
Lectotype (selected here) in FLAS: no. F 14861, coll. J.Matz, Aug. 1915. In leaves, branches and fruit of *Ficus carica*. The specimen contains *Rhizoctonia (Moniliopsis) solani*, a synonymy also suggested by Parmeter & Whitney (1970).

moniliformis Ellis & Everh. 1884 - Bull. Torrey bot. Club 11, p.17.
Doubtful taxon (type not extant, no illustration, art. 9.3). Under bark of rotten *Nyssa* log. Considering the characters mentioned in the description, it does not belong to *Rhizoctonia* s.l.

monilioides J.T. Curtis 1939 - Amer. J. Bot. 26, p.395.
Nomen invalidum (no latin diagnosis, art. 36). Type not extant. Endophyte in roots of *Habenaria*, *Liparis*, *Pogonia*, *Sobralia* and *Spiranthes*. The description does not allow a specific identification.

monteithiana F.T. Bennett 1935 - Gardener's Chron. 3rd Ser., 97, p.129. (as "Monteithianum").
Nomen invalidum (no latin diagnosis, art. 36, provisional name, art. 34). Causal agent of dollarspot disease in *Poaceae*. Bennett stated that the name was of provisional status. The description indicates an ascomycetous relationship, not *Rhizoctonia* s.l.

mucoroides Bernard 1909 - Ann. Sci. Nat. Bot. IX, ser. 9, p.33.
Type not extant. Endophyte in *Phalaenopsis* and *Vanda* spp. An authentic strain, CBS 126.08 (=ATCC 24974), has multinucleate cells and dolipores (Burpee et al. 1980). Bernard considered it closely related to *R. crocorum*, but from the characters in the protologue and the observations by Burpee et al. (1980), it is considered to be a synonym of *Rhizoctonia (Moniliopsis) solani*.

muneratii E. Castellani 1936 - Nuovo Giorn. bot. Ital., n. Ser., 43, p.563.
Nomen invalidum (no latin diagnosis, art. 36). In *Erigeron canadense*. An authentic strain, CBS 298.37 (= ATCC 13247), is binucleate (Parmeter and Whitney, 1970), has dolipores and belongs to CAG-6 of *Ceratobasidium cornigerum* (Burpee et al. 1980).

muscorum Fr. 1822 - Syst. Mycol. 2, p.265.
Type in U: Fr. exs. no. 174. The protologue states close resemblance to *Sclerotium muscorum*. The type specimen contains an orange, sterile, sclerotioid structure, which is not identifiable, but does not belong to *Rhizoctonia* s.l.

nandorii Biradar & Bonde 1976 - Maharashtra V.M. Patrika 11, p.18.
Nomen invalidum (no latin diagnosis, art. 36). A fossil from Kamthi. As a fossil it should not be referred to *Rhizoctonia*.

napaeae Westendorp & Wallays apud Westendorp 1846 - Herbier cryptogamique, fasc. 5, no. 225.
Type in BR: no. 225, Herbier cryptogamique, fasc. 5. In leaves of *Brassica napus*. The type specimen is conspecific with *Rhizoctonia (Moniliopsis) solani*. Since *R. napaeae* West. & Wall. antedates *R. solani* Kühn, *R. napaeae* has priority, and should be used instead of *R. solani*. However, the taxon is of considerable economical importance as a very widespread pathogen, and the name *R. solani* has been generally used for the taxon. The authors feel that there is ample reason for conserving the name *R. solani* over *R. napaeae*, and a proposal for a nomen conservandum is being prepared for submission. The authors encourage continued use of *R. solani* until a decision has been reached regarding conservation. There are at least four spelling variants for this name: *R. rapae* West. & Wall. apud West. (1852), *R. napae* West. apud Kickx (1867), *R. napi* West. apud Kickx sensu Saccardo (1899, p.1176), and sensu Oudemans (1921, p.238), and *R. napeae* West. sensu Oudemans (1921, p.252). All authors refer to the same herbarium specimen, Herb. Crypt., fasc.5, no.225.

neottiae Wolff ex Burgeff 1936 - Samenkeimung der Orchideen und Entwicklung ihrer Keimpflanzen, p.141.
Orcheomyces neottiae Wolff 1926 - Jb. wiss. Bot. 66, p.30.
Nomen invalidum. Type not extant, no authentic strain available. Endophyte in roots of *Neottia*. Wolff (1926) described a taxon in *Orcheomyces* ascribed to Burgeff. However, Burgeff never erected this genus (Burgeff 1911), and *Orcheomyces neottiae* Wolff must be a nomen nudum. Likewise, *R. neottiae* Wolff ex Burgeff is a nomen nudum, since Burgeff neglected to write a latin diagnosis (art. 36). It could be argued, that *R. neottiae* should be ascribed solely to Burgeff, but it would still be a nomen nudum. It is considered to be *Rhizoctonia (Moniliopsis) solani*.

orobanches Mérat 1821 - Nouvelle Flore des environs de Paris 1, p.135.
Tuburcinia orobanches Fr. 1832 - Syst. Mycol. 3, p.439.
Doubtful taxon. (type not extant, no illustration, art. 9.3). In *Orobanche*. The description does not indicate relation to *Rhizoctonia* s.l.

oryzae Ryker & Gooch 1938 - Phytopathology 28, p.238.
Moniliopsis oryzae (Ryker & Gooch) Moore 1987 - Mycotaxon 29, p.95. (nomen invalidum)
Nomen invalidum (no latin diagnosis, art. 36). Type not extant. Causing sheath spot in *Oryza sativa*. An authentic strain, CBS 273.38, is multinucleate and has dolipores (Burpee et al. 1980). They considered *R. oryzae* to be a synonym of *Rhizoctonia (Moniliopsis) solani*. From anastomosis experiments it was considered to be the anamorph of *Waitea circinata* by Oniki et al. (1985).

oryzae-sativae (Sawada) Mordue 1974 - C.M.I. Descr. path. Fung Bact. 4., no. 409.
Sclerotium oryzae-sativae Sawada 1919 - Trans. Nat. Hist. Soc. Formosa 9, p.138 (page cited as 13B).
Ceratorhiza oryzae-sativae (Sawada) Moore 1989 - Ant. van Leeuwenh. 55, p.394.
Type not extant. In roots of *Oryza sativa*. **Lectotype** (selected here): Pl.7, Figs.18-22 in Sawada 1922 - Descriptive catalogue of the Formosa fungi 2. No illustration appeared in the protologue, hence the figures from Sawada (1922). Although nuclear number is not mentioned in the protologue, it is considered to be correct to place the taxon in *Ceratorhiza* (Moore 1989), based on a comparison of the type description and the recombination by Mordue (1974), and a study on teleomorph

relations (Gunnell & Webster 1987).

pallida Matz 1921 - J. Dep. Agric. Porto Rico 5, p.28. (as "palida").
Type not extant. In roots of sugar cane. According to Parmeter and Whitney (1970) the fungus is not *Rhizoctonia solani*. The flat, embedded sclerotia and the colony description suggest the anamorph of *Athelia* sp., and hence does not belong to *Rhizoctonia* s.l.

papayae Ciferri.
Nomen invalidum (art. 29). The name only occurs in a letter arriving together with a strain, CBS 255.28, deposited by Ciferri. The strain is multinucleate, has simple septa (Burpee et al. 1980), and does not belong to *Rhizoctonia* s.l.

pini-insignis E. Castellani 1935 - Annali R. Ist. sup. agr. for. naz., Ser. 2a, 5, p.72.
Nomen invalidum (no latin diagnosis, art. 36). In roots of *Pinus insignis*. An authentic strain, CBS 312.35, is binucleate (Parmeter & Whitney, 1970) and has dolipores (Burpee et al. 1980). The description does not allow specific identification.

placenta Schw. 1832 - Trans. Amer. phil. Soc. 4, p.264.
Doubtful taxon (type not extant, no illustration, art. 9.3). On rotten cortex of tree. The characters do not conform with the circumscription of *Rhizoctonia* s.l.

potomacensis Wollenweber 1913 - Ber. deut. bot. Gesellsch. 31, p.30.
Type not extant, no illustration. In *Lycopersicon esculentum*. *R. potomacensis* is considered to be conspecific with *Rhizoctonia (Moniliopsis) solani*, as also suggested by Parmeter and Whitney (1970).

praticola Saksena & Vaartaja 1961 - Can. J. Bot. 39, p.637.
Nomen invalidum (no latin diagnosis, art. 36). Type not extant. In *Picea*. The name was proposed for the anamorph of *Corticium praticola* "to distinguish it from *R. solani*". The "praticola" strains are considered to belong to AG-4 of *R. solani* (Anderson et. al. 1972, Neate & Warcup 1985). Papavizas (1965) found no distinguishing characters between *R. praticola* and *R. solani* when comparing single spore isolates. There is no basis for distinguishing a separate species, *R. praticola*. It is considered to be *Rhizoctonia (Moniliopsis) solani*.

psycodis Thomas 1925 - Onderzoekingen over *Rhizoctonia*, Utrecht, p.23.
Nomen invalidum (provisional name, art. 34). Type not extant. Endophyte in *Habenaria*. Though the epithet was used, it was not intended to describe a new species (Thomas 1925). The name was also incorrectly being ascribed to Burgeff.

quercina Hartig 1876 - Zeitschr. f. Forst- und Jagdwesen 8, p.329.
Type not extant. In *Quercus*. It was later recognized by the author that it does not belong to *Rhizoctonia* s.l., but was the anamorph of *Rosellinia quercina* Hartig (1880).

quercus E. Castellani 1935 - Annali R. Ist. sup. agr. for. naz., Ser. 2a, 5, p.74.
Nomen invalidum (no latin diagnosis, art. 36). In roots of *Quercus pedunculata*. An authentic strain, CBS 313.35, is uninucleate and has dolipores (Burpee et al. 1980). Parmeter & Whitney (1970) consider the strain binucleate. Identification is not possible from the description.

radiciformis Schw. 1832 - Trans. Amer. phil. Soc. 4, p.264.
Doubtful taxon (type not extant, no illustration, art.9.3). In rhizome of *Iris*. The characters do not conform with the circumscription of *Rhizoctonia* s.l.

ramicola Weber & Roberts 1951 - Phytopathology 41, p.618.
Ceratorhiza ramicola (Weber & Roberts) Moore 1987 - Mycotaxon 29, p.94.

Type in FLAS: no. F41694. In living twigs, petioles and leaf blades of *Elaeagnus pungens*. The type specimen contains two different fungal elements which are both mentioned in the protologue. A sterile mycelium on the leaves and petioles, consisting of hyphae, which can be considered to be of *Rhizoctonia* affinity. Also the brown, necrotic spots on the leaves, in which small cavities containing black bundles of hyphae were found as well. No connection between the two elements could be found, and the necrotic spots cannot be considered to be caused by *Rhizoctonia ramicola* and should be disregarded as such.

Burpee et al. (1980) suggest that this taxon belongs to CAG-7 of *Ceratobasidium cornigerum*. Other authors consider the teleomorph to be distinct as *Ceratobasidium ramicola* Tu, Roberts & Kimbrough (1969). Since the anamorph is described as producing no sclerotia or monilioid cells there are few arguments for referring it to *Rhizoctonia* s.l., but it may be justified to refer the taxon to *Ceratorhiza* due to the number of nuclei and pore structure (Moore 1987).

repens Bernard 1909 - Ann. Sci. nat IX, ser. 9, p.31.
Epulorhiza repens (Bernard) Moore 1987 - Mycotaxon 29, p.95.

Doubtful taxon. Neither type nor authentic cultures extant. Endophyte in *Cattleya* sp. The description and figure does not allow a specific identification (Andersen 1990). Warcup & Talbot (1967) consider the teleomorph to be *Tulasnella calospora*, and a neotype may be chosen from one of their strains.

robusta Burgeff 1936 - Samenkeimung der Orchideen und Entwicklung ihrer Keimpflanzen, p.135.

Nomen invalidum (no latin diagnosis, art. 36). Type not extant. No authentic strain available. Endophyte in roots of *Oncidium cavendishianum*. The description does not allow a specific identification.

rubi McKeen 1959 - Can. J. Plant Sci. 39, p.82.

Nomen invalidum (no holotype specified, art. 37). In fruit of *Rubus* sp. An authentic strain, CBS 382.59, has 1-4 nuclei per cell and has simple, ascomycetous pores. It does not belong to *Rhizoctonia* s.l.

rubiae J. Decaisne 1837 - Recherches anatomiques et physiologiques sur la Garance, p.55.

Type not extant, no illustration. In *Rubia tinctorum*. A synonym of *R. crocorum* fide Duggar (1915). The characters mentioned in the description supports this suggestion.

rubiginosa Sappa & Mosca 1954 - Allionia 2, p.182.

Doubtful taxon. Type not extant. In forest soil. Unauthentic but comparable isolates were identified as *Iodophanus carneus* (Pers.:Fr.) Korf by Warcup and Talbot (1966). The characters do not support its retention in *Rhizoctonia* s.l.

sclerotica Burgeff 1936 - Samenkeimung der Orchideen und Entwicklung ihrer Keimpflanzen, p.132.

Nomen invalidum (no latin diagnosis, art. 36). Type and authentic culture not extant. Endophyte in roots of *Ophrys muscifera (insectifera)*. The description does not allow a positive identification.

silvestris Melin 1923 - Mykologische Untersuchungen und Berichte 2, p.146.

Doubtful taxon. Type and authentic culture not extant. In seedlings of *Pinus silvestris*. The description suggests ascomycetous affinity, and does not conform with the circumscription of *Rhizoctonia* s.l.

solani Kühn 1858 - Die Krankheiten der Kulturgewächse, ihre Ursachen und ihre Verhütung, p.224.
Moniliopsis solani (Kühn) Moore 1987 - Mycotaxon 29, p.95.

Type not extant (Kühn has stated that he did not typify (Duggar 1915)). In *Solanum tuberosum*. This is the most well known species of *Rhizoctonia* s.l., and its teleomorph is *Thanatephorus cucumeris* (Frank) Donk. A neotype might be selected from AG-3 as also suggested by Sneh et al. (1991). As previously mentioned, a proposal is being prepared for conservation of *R. solani* against *R. napaeae*.

solani f. **paroketea** Ciferri 1938 - Ann. Mycol. 36, p.245.

Type in BPI: Mycoflora Domingensis no. 4300 (USO 456108). **Isotype** in W. In residue of starch roots of *Manihot esculenta*. The type specimen contains *Sclerotium rolfsii*.

solani var. **ambigua** Baldacci & Cabrini 1939 - Att. Ist. Bot. di Pavia 11, ser. IV^{a}, p.60.

Type not extant. In *Phaseolus*. Based on the protologue, the status as a new variety of *Rhizoctonia (Moniliopsis) solani* cannot be considered to be justified.

solani var. **brassicae** Sneh, Burpee & Ogoshi 1991 - Identification of Rhizoctonia species. APS Press, p.67.
Hypochnus solani var. *brassicae* Schultz 1936 - Arb. Biol. Reichsanst. Berlin 22, p.30. (nomen invalidum).

Nomen invalidum (no latin diagnosis, art. 36). It is wrongly ascribed to Schultz, who never published it in *Rhizoctonia*. Since *Hypochnus solani* var. *brassicae* was published without a latin diagnosis and therefore an invalid name, it cannot be used as basionym, and the variety described in *Rhizoctonia* must be ascribed solely to Sneh et al. (1991).

solani var. **cedri-deodarae** E. Castellani 1935 - Annali R. Ist. agr. for. naz., Ser. 2a, 5, p.68.

Nomen invalidum (no latin diagnosis, art. 36). Type not extant. In roots of *Cedrus deodarus*. An authentic strain, CBS 318.35, is *Rhizoctonia (Moniliopsis) solani* and belongs to AG-4. From the description it is not distinguishable as a variety.

solani var. **cichorii-endiviae** Schultz 1936 - Arb. Biol. Reichsanst., Berlin 22, p.30.

Nomen invalidum (no latin diagnosis, art. 36). In *Cichorium endivia*. It is Group IV of Schultz (1936), which corresponds to AG-4. Strain "Schultz 11", CBS 199.25, belongs to this group.

solani var. **fuchsiae** Schulz 1936 - Arb. Biol. Reichsanst., Berlin 22, p.30.

Nomen invalidum (no latin diagnosis, art. 36). In *Fuchsia* and *Begonia*. It is a name for Group V of Schulz (1936).

solani var. **graminis** Bunschoten.

Nomen invalidum. Mentioned by Parmeter and Whitney (1970), but the name has never been published. G. Bunschoten worked at the CBS, and no record of publication was found there.

solani var. **hortensis** Schulz 1936 - Arb. Biol. Reichsanst. Berlin 22, p.30.

Nomen invalidum (no latin diagnosis, art. 36). In *Hydrangaea hortensis*. It is a name for Group I of Schultz (1936), which corresponds to AG-1.

solani var. **lycopersicae** Schultz 1936 - Arb. Biol. Reichsanst. Berlin 22, p.30.

Nomen invalidum (no latin diagnosis, art. 36). In *Lycopersicum esculentum*.

solani var. **typica** Sneh, Burpee & Ogoshi 1991 - Identification of Rhizoctonia species. APS Press, p.67.
Hypochnus solani var. *typica* Schultz 1936 - Arb. Biol. Reichsanst. Berlin 22, p.30. (nomen invalidum).
Nomen invalidum (no latin diagnosis, art. 36). It is wrongly ascribed to Schultz, who never published it in *Rhizoctonia*. Since *Hypochnus solani* var. *typica* is published without a latin diagnosis and therefore an invalid name, it cannot be used as basionym, and the variety described in *Rhizoctonia* must be ascribed solely to Sneh et al. (1991).

sphacelati Burgeff fide Sneh, Burpee & Ogoshi 1991 - Identification of Rhizoctonia species. APS Press, p.74.
Nomen invalidum (provisional name, art. 34). Burgeff never published the name in *Rhizoctonia*, but he mentioned a M.R. (Mycelium radices) sphacelati which he specifically stated was of provisional character (Burgeff 1911).

stahlii Burgeff 1936 - Samenkeimung der Orchideen und Entwicklung ihrer Keimpflanzen, p.132.
Nomen invalidum (no latin diagnosis, art. 36). Type not extant. Endophyte in roots of *Platanthera chlorantha*. CBS 119.12 is called *R. stahlii*, but no longer produces monilioid cells or sclerotia. The description gives no further clue to the identity of the fungus.

strobi E. Scholz 1897 - Verhandl. zool.-bot. Gesellsch. Wien 47, p.555.
Doubtful taxon. Type not extant. In roots of *Pinus strobus*. The description mentioned black rhizomorphs and black sclerotia, which suggests ascomycetous affinity, and does not conform with the circumscription of *Rhizoctonia* s.l.

strobilina (Schmidt) Link 1824 - Spec. Plant. 1, (ed.VI, Wildenow), p.120.
Sclerotium strobilinum Schmidt in Kuntze & Schmidt 1817 - Mykol. Hefte 1, p.85.
Doubtful taxon (type not extant, no illustration, art. 9.3). In *Picea excelsa*. Link (1824) is also in doubt, stating: "An hujus generis? Non vidi!". The description is too insufficient to warrant any suggestion of identity.

suavis Thomas 1925 - Onderzoekingen over *Rhizoctonia*, Utrecht, p.23.
Nomen invalidum (provisional name, art. 34). Type not extant. Endophyte in *Vanda* sp. The name was incorrectly ascribed to Burgeff.

subepigaea Bertoni 1897 - Rev. Agr. Cient. apl. Paraguay 1, p.211.
Type not extant. In *Coffea* sp. The branching pattern and production of conidia as mentioned in the protologue does not conform with the circumscription of *Rhizoctonia* s.l.

subtilis Burgeff 1936 - Samenkeimung der Orchideen und Entwicklung ihrer Keimpflanzen, p.130.
Nomen invalidum (no latin diagnosis, art. 36). Type not extant. No authentic strains available. Endophyte in roots of *Lycaste skinneri*. The description is too scanty to warrant any suggestion of the identity of the fungus.

subtilis var. **nigra** J.T.Curtis 1939 - Amer. J. Bot. 26, p.395.
Nomen invalidum (no latin diagnosis, art. 36). Type not extant. No authentic strains available. Endophyte in *Spiranthes cernua*. It may be an ascomycete belonging to *Leptodontidium*, *Phialocephala* or *Phialophora* (Currah et al. 1988).

tabifica Hallier 1875 - Zeitschr. Parasitenkde 4, p.123.
The name is a synonym of *Colletotrichum atramentarium* (Dickson 1926), and not a *Rhizoctonia* s.l.

tomato Bahariev 1984 - Compt. rend. Acad. Bulg. Sci. 37, p.1269. (as *"Rhisoctonia"*).
Nomen invalidum (no latin diagnosis, art. 36, no holotype specified, art. 37). No host was indicated. The description gives no clue to its identity.

tricolor Ellis & Everh. 1884 - Bull. Torrey Bot. Club 11, p.17.
Doubtful taxon (type not extant, no illustration, art. 9.3). The name was probably not intentionally published. It was mentioned in a discussion on *R. aurantiaca* and was probably an orthographic error for *R. bicolor*, since the authors referred to a fungus with sclerotia black outside and red within, which matches the type specimen of *R. bicolor*.

tuliparum Whetzel & Arthur 1925 - Cornell Agric. Exp. St. Mem. Nr. 89, p.10.
Sclerotium tuliparum Klebahn 1905 - Jb. Hamb. wiss. Anst. 22, Beih. 3, p.13, [non Schlechtendal 1831].
Type not extant. In diseased bulbs of *Tulipa*. Since *S. tuliparum* Klebahn is a later homonym of *S. tuliparum* Schlechtendal, *R. tuliparum* is ascribed solely to Whetzel & Arthur (1925). It is considered to be synonymous with *Rhizoctonia (Moniliopsis) solani*.

versicolor E. Müller & Nüesch 1960 - Phytopathol. Z. 38, p.286.
Nomen invalidum (no holotype specified, art. 9.5 and art. 37). The type deposition refers to a culture which is no longer present at ETHZ. Endophyte in roots of *Himanthoglossum hircinum*. CBS 701.82 is stated by G.C. Adams (pers. comm.) to be the type strain. From the description it does not belong to *Rhizoctonia* s.l. but is possibly a *Nodulisporium* sp. (R.S. Currah pers. comm.).

violacea Tul. & C.Tul. 1862 - Fungi Hypogaei, p.188.
In *Crocus*. Superfluous name. It was introduced with *R. crocorum* in synonymy; hence it is a synonym of *R. crocorum*.

violacea f. **dauci** Kühn in Rabenh. 1875 - Kryptogamensammlung, Syst. Übersicht, sect. I, Pilze (F. e. No 1965).
Type in B: Rabenhorst III: Fungi europaei no. 1965. **Isotype** in L: no. 910.246-521, F.E. no. 1965. In *Daucus carota*. Both specimens contain *R. crocorum*. The host seems to be the only reason for the proposal of a new taxon, which is not warranted. The literature citation on both specimens (Kühn: Kr. d. Kult. Gew.: 243) does not refer to an earlier publication of the name but only to a note about a fungus on carrot in Kühn (1858).

zeae Voorhees 1934 - Phytopathology 24, p.1299.
Moniliopsis zeae (Voorhees) Moore 1987 - Mycotaxon 29, p.96.
Type in FLAS: no. F 15854. Type strain: CBS 384.34. Causal agent of ear rot of *Zea mays*. Oniki et al. (1985) considered it to be the anamorph of *Waitea circinata* Warcup & Talbot. The type specimen has been severely damaged by insects, and it was not possible to identify fungal structures referable to *Rhizoctonia (Moniliopsis) zeae*. Furthermore, the type strain, CBS 384.34, is morphologically degenerated and produces neither sclerotia nor monilioid cells. Its status as the anamorph of *Waitea circinata* is, however, confirmed by DNA-analysis (Andersen in prep.), and the taxon is considered to be distinct.

DISCUSSION

The list includes 119 epithets on specific and subspecific level described in *Rhizoctonia*. In the tables 1-6 the epithets are listed according to their status considered in this paper. 48 epithets are not validly published (TABLE 1), and 30 taxa are excluded from *Rhizoctonia* s.l. (TABLE 2).

The remaining 41 taxa are validly published, and conform with the circumscription of *Rhizoctonia* s.l. Of these taxa 9 were too poorly described to delimit the taxa from other taxa in *Rhizoctonia*. They were considered to be doubtful taxa (TABLE 3). Of the 32 taxa referable to *Rhizoctonia* which were recognizable, the authors considered 7 taxa to be synonymous with *Rhizoctonia crocorum* (TABLE 4), and 17 were considered to be synonymous with *Rhizoctonia (Moniliopsis) solani* (TABLE 5). *Rhizoctonia fumigata* is considered to be synonymous with *Rhizoctonia (Ceratorhiza) oryzae-sativae* as suggested by Moore (1989).

Including the type species of the form genus, *Rhizoctonia crocorum*, a total of seven taxa are considered to be validly published, well described, recognizable and referable to *Rhizoctonia* DC. s.l. (TABLE 6). They are all referable to one of the four genera considered by Moore (1987).

TABLE 1. A list of *Rhizoctonia* names, which are not validly published according to the International Code of Botanical Nomenclature (nomina nuda and provisional names).

R. alpina
R. apocynacearum
R. asclerotica
R. bicolor
R. borealis
R. callae
R. candida
R. cavendishiani
R. cerealis
R. dichotoma
R. endophytica v.e.
R. endophytica v.filicata
R. fragariae
R. fraxini
R. fuccosa
R. globularis
R. gracilis
R. juniperi
R. lupini
R. monilioides
R. monteithiana
R. muneratii
R. nandorii
R. neottiae
R. oryzae
R. papayae
R. pini-insignis
R. praticola
R. psycodis
R. quercus
R. robusta
R. rubi
R. sclerotica
R. solani v.brassicae
R. solani v.cedri-deodarae
R. solani v.cichorii-endiviae
R. solani v.fuchsiae
R. solani v.graminis
R. solani v.hortensis
R. solani v.lycopersicae
R. solani v.typica
R. sphacelati
R. stahlii
R. suavis
R. subtilis
R. subtilis v. nigra
R. tomato
R. versicolor

Considering the large number of teleomorphic taxa in the genera which possess a *Rhizoctonia* anamorph, the seven anamorph taxa are hardly sufficient to accommodate all strains referable to *Rhizoctonia* s.l. Therefore, it will be necessary to introduce new taxa or validate older names by fulfilling the requirements of the ICBN. However, this must be done with great care if the anamorph identification should become reliable.

It is therefore recommended, that new descriptions or neotypifications are accompanied by description of all available characters, with properly preserved type specimen (holo- and isotypes) and photographs as documentation. These characters include: ultrastructure of the pore, number of nuclei per cell, hyphae, monilioid cells, and sclerotia. If isolated as a pathogen, the type specimen should also contain the parts of the host plant showing the symptoms of the disease. It must also be specified, that compliance with recommendation 9A.1 of the ICBN, regarding the preparation of a living culture from the holotype material, is increasingly important; even degenerate strains showing none of the original morphological characteristics could still be useful in biochemical and genetical tests.

TABLE 2. A list of taxa described in *Rhizoctonia* which are excluded based on protologue and type material examined.

R. aurantiaca
R. batatas
R. bataticola
R. carnea
R. carotae
R. centrifuga
R. coniothecioides
R. destruens
R. fuliginea
R. hiemalis
R. himantia
R. lamellifera
R. leguminicola
R. lilacina
R. menthae
R. moniliformis
R. muscorum
R. orobanches
R. pallida
R. placenta
R. quercina
R. radiciformis
R. rubiginosa
R. silvestris
R. solani f. paroketea
R. strobi
R. strobilina
R. subepigaea
R. tabifica
R. tricolor

TABLE 3. List of taxa which are considered to be doubtful due to poor descriptions and lack of type material.

R. aerea
R. alba
R. arachnion
R. brassicarum
R. floccosa
R. goodyerae repentis
R. lanuginosa
R. mali
R. repens

TABLE 4. List of taxa placed in synonymy with *Rhizoctonia crocorum*.

Rhizoctonia allii
Rhizoctonia asparagi
Rhizoctonia dauci
Rhizoctonia medicaginis
Rhizoctonia rubiae
Rhizoctonia violacea
Rhizoctonia violacea f. dauci

TABLE 5. List of taxa placed in synonymy with *Rhizoctonia (Moniliopsis) solani*.

Rhizoctonia aderholdii
Rhizoctonia betae
Rhizoctonia chousii
Rhizoctonia dimorpha
Rhizoctonia ferrugena
Rhizoctonia fusca
Rhizoctonia gossypii v.aegyptiaca
Rhizoctonia gossypii v.gossypii
Rhizoctonia grisea
Rhizoctonia macrosclerotia
Rhizoctonia melongenae
Rhizoctonia microsclerotia
Rhizoctonia mucoroides
Rhizoctonia napaeae
Rhizoctonia potomacensis
Rhizoctonia solani v. ambigua
Rhizoctonia tuliparum

TABLE 6. List of recognized taxa of *Rhizoctonia* s.l.

Rhizoctonia (Epulorhiza) anaticula
Rhizoctonia (Moniliopsis) anomala
Rhizoctonia crocorum
Rhizoctonia (Ceratorhiza) oryzae-sativae
Rhizoctonia (Ceratorhiza) ramicola
Rhizoctonia (Moniliopsis) solani
Rhizoctonia (Moniliopsis) zeae

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STUDIES OF THE GENUS AMANITA FROM SOUTHWESTERN CHINA (I)

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Summary

Four taxa of the genus Amanita from SW China are reported and fully described in this paper. They are A. sychnopyramis Corner et Bas f. subannulata Hongo, A. hemibapha (Berk. et Br.) Sacc. cf. subsp. hemibapha, A. pseudoporphyria Hongo, and A. yuaniana Z. L. Yang, the latter one of which is new to science. Edibility of the latter two species is also briefly discussed.

KEY WORDS: Amanita; A. yuaniana; taxonomy; distribution; SW China

The genus Amanita from China has been taxonomically studied by many mycologists (Patouillard, N., 1895; Teng, S. C., 1936; Lohwag, H., 1937; Chiu, W. F., 1948; Teng, S. C., 1963; Wang, Y. C., 1973; Tai, F. L., 1979; Zang, M., 1980; Peng, Y. B. and L. H. Liu, 1981; Ying, J. Z., J. D. Zhao, X. L. Mao, Q. M. Ma, L. W. Xu and Y. C. Zong, 1982; Wang, Y. C., M. Zang et al, 1983; Chen, Z. C.,1984; Xie, Z. C., Y. Wang and B. Wang, 1986; Imazeki, R. and T. Hongo, 1987; Mao, X. L., 1987; Ying J. Z., X. L. Mao, Q. M. Ma, Y. C. Zong and H. A. Wen, 1987; Bi, Z. S., G. Y. Zheng, T. H. Li and Y. Z. Wang, 1990; Mao, X. L., 1990; Li, R. G., 1991; Liu, B., 1991; Mao, X. L., 1991; Peng, J. T., C. J. Chen and J. Hua, 1991; and others). About 55 species have been so far reported from China. In spite of these numerous contributions, the Amanitas in China are still very poorly known as compared to those in some other regions of the world. Further studies appear necessary. In the last two years the present author has devoted much attention to the Amanitas of Yunnan and Sichuan Provinces, Southwestern China. Some results of this research are reported here.

1. Amanita sychnopyramis Corner et Bas in Persoonia 2: 291, Pl. 8c, 9b, figs. 38 - 39, 1962.

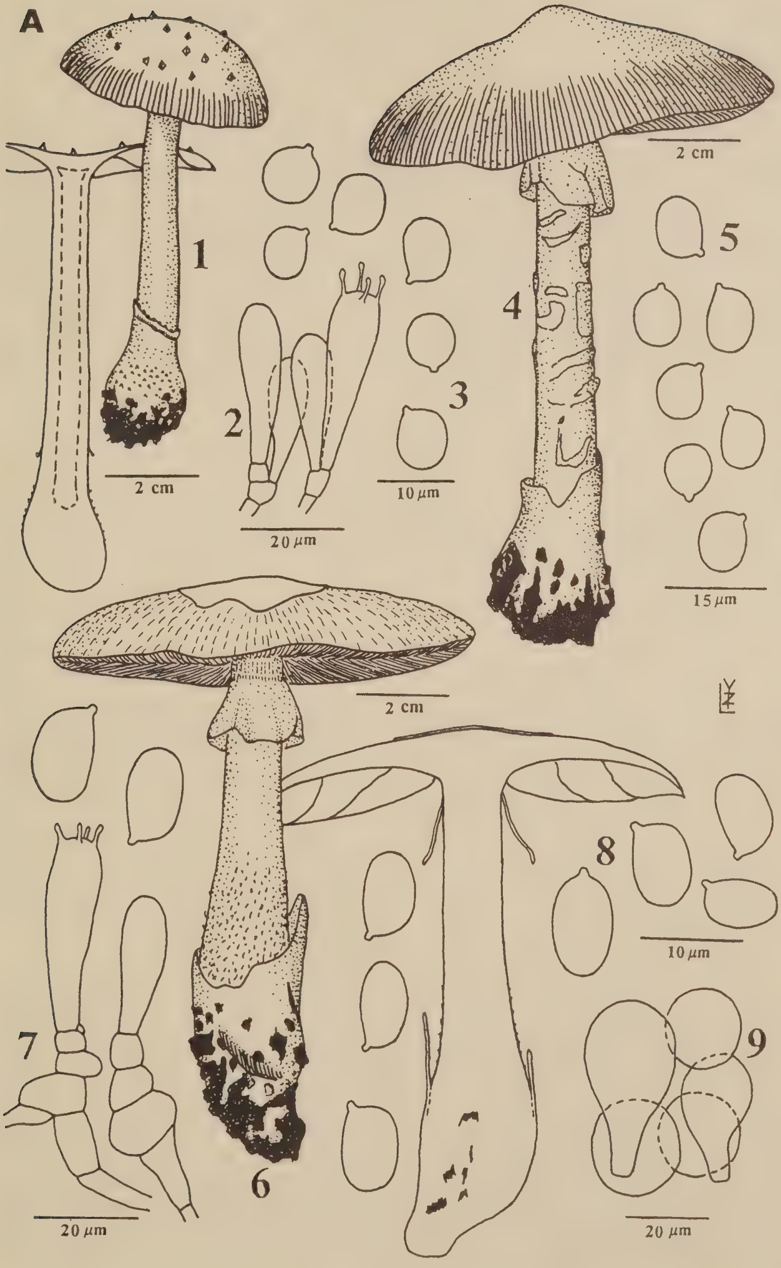
   f. subannulata Hongo in Mem. Shiga Univ. 21: 63, fig. 31 / 3 - 5, 1971 Fig. A / 1 - 3

Pileus 3 - 8 cm wide, convex to plano-convex, slightly depressed at the disc, concave when fully mature; surface pale brown, grayish brown, umber to dark brown, paler to whitish or grayish towards margin, covered with whitish to creamy conical squamules; margin long striate. Lamellae free, white, 5 - 10 mm wide, moderately crowded; lamellulae truncate to rounded truncate (shorter ones) to attenuate (longer ones); margin finely farinose. Stipe 7 - 11 X 0.7 - 1.5 cm, subcylindrical to slightly attenuate upwards, with a swollen base, hollow; surface white to creamy, glabrous, near the upper base covered with several irregular circles of grayish, creamy or yellowish granulate to subconical squamules. Annulus usually on the lower part of the stipe, white to creamy,with creamy or brownish limb. Pileus context white, up to 5 mm thick in the center, thin at the margin.

Spores [105 spores from 5 specimens of 5 collections measured in 3% KOH] 6.0 - 7.5 (-8.5) X (5.0-) 6.0 - 6.8 (-7.5) μm, subglobose (average length (per specimen) = 6.6 - 7.3 μm; average length (all specimens) = 6.9 μm; average width (per specimen) = 6.1 - 6.8 μm; average width (all specimens) 6.4 μm; Q =1.00 - 1.08 (-1.30); average Q (per specimen) = 1.05 - 1.13; average Q (all specimens) = 1.08), hyaline, thin-walled, smooth, inamyloid. Basidia 30 - 35 X 10 - 12 μm, usually 4-spored. Subhymenium of slightly inflated segments and small subglobose cells. Universal veil on pileus of more or less erect chains of inflated cells,10 - 60 X 10 - 25 μm, mixed with undifferentiated hyphae, 3 - 5 μm wide, branching; on base of stipe consisting of undifferentiated hyphae,3 - 4μm wide; inflated cells subglobose to ellipsoid.Annulus dominantly consisting of undifferentiated hyphae, 2 - 6 μm wide, hyaline, branching; inflated cells rare, subglobose to ellipsoid to 20 - 30 X 10 - 20 μm, or clavate to 30 - 40 X 8 - 12 μm; with the limb largely consisting of inflated cells, subglobose to subellipsoid to bucilliform to narrowly clavate to clavate, 16 - 40 X 8 - 30 μm, slightly thick-walled, often clustered in short chains, mixed with branching, undifferentiated hyphae, 2 - 5 μm wide. Pileipellis up to 150 μm thick, composed of filamentous, undifferentiated hyphae, 2 - 12 μm wide, hyaline, subradically arranged, slightly gelatinized near surface. Stipe context acrophysalidic;undifferentiated hyphae 3 - 18 μm wide, branching; acrophysalides 100 - 140 X 28 - 50 μm. Clamps not observed.

Specimens observed: YUNNAN: Xichou, alt. 1550 m,16 VI 1992,Yang, Z. L.1717 (HKAS 26141), ibid. 18 VI 1992, Yang, Z. L. 1743 (HKAS

Fig. A: *Amanita* *sychnopyramis* f. *subannulata* (HKAS 26142): 1.basidiocarps, 2. hymenium and subhymenium, 3. spores; *A. hemibapha* cf. subsp. *hemibapha* (HKAS 24203): 4. basidiocarp, 5. spores; *A. pseudoporphyria* (HKAS 26145): 6. basidiocarps, 7. hymenium and subhymenium, 8. spores, 9. marginal cells of lamellae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26144), Yang, Z. L. 1744 (HKAS 26142), Liu, P. G. 1119 (HKAS 26140); Malipo, alt. 1400 - 1600 m, 23 VI 1992, Yang, Z. L. 1759 (HKAS 26143). On soil in forests dominated by Castanopsis spp. and Lithocarpus spp.

Remarks: The present taxon is characterized by the conical warts on the brown pileus, the remnants of volva around the top of the bulbous base, the inferior annulus and the small spores. The above cited collections seem to have slightly smaller spores as compared with those reported by Hongo (1971). The taxon is poisonous. The author has observed in the field that many flies are poisoned soon after biting basidiomes of this species. As Hongo (1982) suggested A. kwangsiensis Wang, the type of which has been reviewed by Dr. R. E. Tulloss (personal correspondence), is very close to this form if not conspecific.

Distr.: Japan, China.

2. Amanita hemibapha (Berk. et Br.) Sacc., Syll. Fung. 5:13, 1887. ——— Agaricus hemibaphus Berk. et Br. in Trans. Linn. Soc. London 27: 149, Pl.33, fig. A, 1871.

cf. subsp. hemibapha Fig. A / 4 - 5

Pileus up to 9 cm wide, convex to plano-convex, umbonate; surface scarlet, flame-scarlet or somewhat deep red, yellow towards the margin, viscid when wet; margin strongly striate about half way to the center. Lamellae free, yellowish to yellow, 5 - 8 mm wide, moderately crowded; lamellulae subtruncate to attenuate.Stipe 11 X 1 - 1.5 cm, slighly expanded towards the base, hollow; surface pale yellow to yellowish, marked with yellow scaly zones or squamules below the ring; yellow, striate, fibrillose above the ring, with sheathing volva. Annulus large, thin membranous, pendant, yellowish, persistent. Volva white, rather thick, lobed. Pileus context white to yellowish, up to 6 mm thick at the disc; taste mild.

Spores [40 spores from 1 specimen of 1 collection measured in 3% KOH] (6.0 -) 7.0 - 9.0 (-9.5) X 6.0 - 7.0 (-8.0) µm, broadly ellipsoid to subglobose (average length = 8.0 µm, average width = 6.6 µm, Q = (1.06-) 1.08 - 1.28 (-1.38), average Q = 1.20), hyaline, thin-walled, smooth, inamyloid. Basidia 38 - 45 X 9 - 12 µm, clavate, 4-spored; clamps relatively common. Subhymenium 25 - 40 µm wide, cellular, with 2 - 3 layers of cells. Pileipellis up to 100 µm thick, consisting of filamentous, undifferentiated hyphae, subgelatinous near surface. Stipe context longitudinally acrophysalidic; acrophysalides clavate to subfusoid, up to 200 X 50 µm, mixed with branching, undifferentiated hyphae, 3 - 8 µm wide.

Specimen observed: YUNNAN: Jingdong, alt. 2350 m, 27 VIII 1991, Yang, Z. L. 1681 (HKAS 24203).

Remarks: The colored photo of this collection was published under the name Amanita caesarea (Scop. : Fr.) Pers. (Yang, C. L., 1992). But the umbonate pileus with strongly striate margin and the hollow stipe with scaly zones or squamules on the surface, the small spores, the subhymeniumm consisting of 2 - 3 layers of cells are close to those of A. hemibapha.The European A. caesarea is characterized by a thick, hardly striate cap usually lacking an umbo,a thick solid, relatively short stem without scaly zones, and larger spores (Bas, 1977; Hongo, 1975), although collections of it with smaller spores have been found in Europe (Bas, 1977). Furthermore, according to Dr. Tulloss (personal correspondence), A. caesarea has a subhymenium 40 - 50 um thick, consisting of 4 - 5 ranks of inflated cells. The type of A. hemibapha subsp. hemibapha was collected in Sri Lanka. Dr. T. Hongo collected this taxon from Jilin, China in 1981 (Imazeki and Hongo, 1987). The above cited collection agrees with the protologue, and other descriptions of it except that the spores are rounder, and the patches on the stipe are not red (Berkeley and Broome,1871; Corner and Bas, 1962; Imazeki and Hongo, 1987; Imazeki, Otani and Hongo, 1988; Pegler, 1986). Dr. Tulloss has reviewed material from India that seems very close to the above cited collection (personal correspondence). In order to determine the taxonomical status of the specimen collected from Yunnan, it is necessary to examine more collections related in future.

Distr.: A. hemibapha subsp. hemibapha was reported from Sri Lanka, India, China, South Korea, Japan. It is probably also distributed in the east portion of Russia (cf. A. caesareoides L. Vassilieva) and U. S. A. (Bas, 1977; Tulloss, 1986).

3. Amanita pseudoporphyria Hongo in Journ. Jap. Bot. 32: 141, fig. 2 / a - c, 1957. Fig. A / 6 - 9

Pileus 8 - 13 cm, convex becoming almost applanate;surface gray, grayish brown, finely innately streaked towards margin, dry or slightly viscid, glabrous or with a few large, thin, white patches from volva; margin not striate. Lamellae free, about 10 mm wide, white, moderately crowded; lamellulae plentiful,truncate to subattenuate, evenly distributed among lamellae. Stipe 8 - 12 X 1.2 - 2 cm, attenuate upwards; surface white, lower part covered with white, floccose squamules.Annulus white, subapical, membranous, persistent. Volva white, lower half to two thirds attached to bulb of stipe, with tallest limb reaching 40 - 60 mm from the stipe base; bulb up to 45 X 25 mm. Pileus context white, up to 10 mm thick at center of the pileus, thinning outwards.

Spores [70 spores from 3 specimens of 2 collections measured in 3% KOH](6.0-) 7.0 - 9.0 (-10.0) X 4.5 - 5.5 (-7.0) µm,ovoid,broadly ellipsoid to ellipsoid (average length (per specimen) = 7.0 - 8.5 µm; average length (all specimens) = 7.8 µm; average width (per specimen) = 5.1 - 5.5 µm; average width (all specimens) = 5.2 µm; Q = (1.20-) 1.33 - 1.67 (-1.86); average Q (per specimen) = 1.39 - 1.55; average Q (all specimens) = 1.49), hyaline, thin-walled, smooth, amyloid. Basidia 25 - 40 X 8 - 10 µm, usually 4-spored; clamps rare. Subhymenium about 30 µm thick, cellular, consisting of 1 - 3 layers of subglobose to short ellipsoid cells. Marginal cells of lamellae subglobose to broadly clavate 10 - 60 X 10 - 30 µm. Pileipellis up to 280 µm thick, consisting of a gelatinous 60 - 170 µm wide upper layer with filamentous, undifferentiated hyphae, 2 - 5 µm wide, subradically arranged, and a 100 - 130 µm wide lower layer with interwoven, undifferentiated hyphae, 5 - 8 µm wide.

Specimens observed: YUNNAN: Kunming, 27 VII 1992,Yang, Z. L.1929 (HKAS 26145), on soil in forest of *Tsuga* sp. HUNAN: Jishou, 21 X 1990, Xiong, Q. 4512 (HKAS 22939), on soil in coniferous forest.

Remarks: Hongo (1957) described the spores of the type of this species as broadly ovate or ellipsoid, measuring 7.5 - 8.5 (9. 5) X 4. 5 - 5.5 (7) µm. Corner and Bas (1962) reviewed the paratype and reported the length-width ratio of its spores to be 1.3 - 1.6. Mao (1991) listed it in his paper. This species is doubtful for its edibility (Hongo, 1957; Imazeki and Hongo, 1987), but it might be edible, although it contains 2-amino-4,5-hexadienoic acid (Hatanaka, 1975), which also occurs in *A. neoovoidea* Hongo (Hatanaka and Kawakami 1980), a species considered edible (Hongo, 1975; Tulloss, Hongo and Bhandary, 1992 .). An edible mushroom with spores measuring 6.5 - 8.0 X 5.5 - 7 µm, often sold at the markets in Kunming, regarded first as *A. manginiana* Har. et Pat. by Prof. Chiu (1948) and later Chinese mycologists, is very similar to this taxon.

Distr.: Japan, South Korea, China.

4. *Amanita yuaniana* Z. L. Yang sp. nov. Fig. B / 1 - 5

Species nova A. alaudae affinis, sed basidiocarpis valde majoribus et sporis ellipsoideis differt; A. pseudoporphyriae affinis, sed pileis maculosis, annulis griseis et sporis majoribus differt.

Pileus 8 - 12 cm latus, convexus, convexo-applanatus,albidus vel griseus, maculationibus griseo-brunneis, subviscidus, margine appendiculato. Lamellae 8 mm latae, albae. Stipes 10 - 12 X 1.2 - 2.0 cm, clavatobulbosus, annulatus, volvatus, infra annulum floccosus vel squamulosus, albidus vel griseus, supra annulum fibrillosus vel farinaceus, griseus. Volva semilibera, albida, crassi-membranacea.

Caro albida. Sporae (8.0-) 9.0 - 11.0 (-12.5) X (6.0-) 7.0 - 8.0 (-8.7) μm, lato-ellipsoideae, amyloideae. Basidia 4-sporigera, 44 - 60 X 9 - 11 μm, subclavata. Fibulae praesentes.

Typus: SICHUAN: Miyi, alt. 2000 m, 27 VII 1986, Yuan, M. S. 1187 (HKAS 18383). In silvis.

Etymology: named after Mr. Yuan, Ming-sheng, collector of the type, who collected some valuable specimens of Agaricales from SW Sichuan, most of which are deposited in HKAS.

Pileus 8 - 12 cm wide, convex to convexo-applanate, slightly depressed at disc when mature; surface whitish to grayish, dark gray at center, paler towards the margin, densely streaked by innate dark fibrils which form grayish to dark brown ["Natal Brown", "Fuscous" or "Fuscous Black" of Ridgway, 1912] spots or speckles; margin barely striate, appendiculate. Lamellae free, white, moderately crowded, up to 8 mm wide; lamellulae moderately plentiful, truncate to subattenuate to subattenuate with small attenuate tooth at attachment to pileus. Stipe 10 - 12 X 1.2 - 2.0 cm, attenuate upwards, with a subclavate base; surface whitish, covered on the lower part of the stipe with white floccose squamules and on the upper with gray squamules below the annulus, gray to grayish fibrillose to farinose above the annulus. Annulus superior, pendant from 1 - 3 cm below apex of stipe, membranous, gray to grayish, persistent. Volva white, lower half attached to bulb of stipe, upper part firm, membranous, free but not spreading, with tallest limb reaching 35 - 60 mm from the stipe base; bulb 30 - 35 X 20 - 25 mm. Pileus context white, about 8 mm thick over disc, thinning towards margin. Odor and taste not recorded.

Spores [90 spores from 3 basidiocarps of 2 collections measured in 3% KOH] (8.0-) 9.0 - 11.0 (-12.5) X (6.0-) 7.0 - 8.0 (-8.7) μm, broadly ellipsoid, rare ellipsoid or subovoid (average length (per specimen) = 10.1 - 10.3 μm; average length (all specimens) = 10.2 μm; average width (per specimen) = 7.3 - 7.5 μm; average width (all specimens) = 7.4 μm; Q= (1.15-) 1.33 - 1.46(-1.57); average Q (per specimen) = 1.36 - 1.38;average Q (all specimens) = 1.37), hyaline, thin-walled, smooth, amyloid; color of spores in deposit unknown. Basidia 44 - 60 X 9 - 11 μm, usually 4-spored, subclavate; clamps relatively common. Subhymenium up to 20 μm thick, consisting of branching, uninflated, narrow, hyphal segments and ellipsoid to subglobose, inflated cells. Lamellar trama bilateral, including hyaline, thin-walled hyphae, 2 - 8 μm wide. Limb of volva with outer surface composed of undifferentiated hyphae, 2 - 18 μm wide, branching, hyaline, slightly thick-walled; clamps relatively common; vascular hyphae 4 - 7 μm wide; the inner surface dominantly composed of undifferentiatedly hyphae, 2 - 8 μm wide, subgelatinous, hyaline, branching;inflated cells subglobose to ellipsoid to 30 - 80 X 20 μm, or clavate to 50 X 12 µm, not common; vascular hyphae 4 - 15 µm wide; the interior dominantly composed of undifferentiated hyphae, 2 - 6 µm wide, branching, slightly thick-walled; clamps relatively common; inflated cells rare, subglobose to ellipsoid to 30 X 50 µm, thin to slightly thick-walled; vascular hyphae abundant, 4 -6 µm wide. Annulus consisting of 3 - 16 µm wide, subgelatinous undifferentiated hyphae; inflated cells common, clavate,narrowly clavate to ellipsoid or subpyriform, occasionally subglobose, 30 - 80 X 17 - 24 (-55) µm. Stipe context longitudinally acrophysalidic; undifferentiated hyphae 4 - 8 µm wide, branching; acrophysalides clavate to subfusiform, 60 - 160 X 20 - 30 µm; vascular hyphae 6 - 12 µm wide. Pileipellis up to 480 µm thick, consisting of a 40 - 120 µm wide, gelatinous upper layer with filamentous, undifferentiated hyphae, 2 - 5 µm wide, hyaline,and a 140 - 360 µm wide lower layer with brown, undifferentiated hyphae, 5 - 12 µm wide.

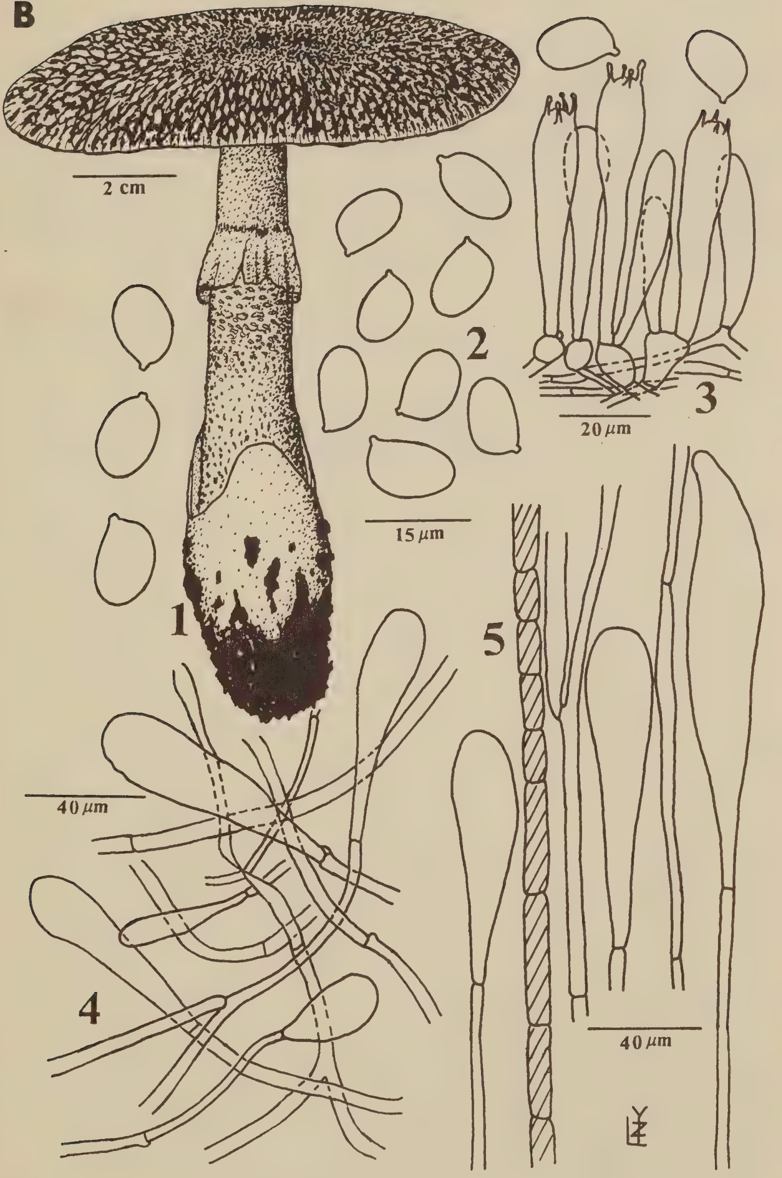
Specimens observed: SICHUAN: Miyi, alt. 2000 m,27 VII 1986,Yuan, M. S. 1187 (HKAS 18383, typus !), growing in forest dominated by Pinus yunnanensis Franch., mixed with scattered trees of the Family Fagaceae; Puge, alt. 2200 m, 52 VII 1992, Sun, P. Q. 1950 (HKAS 25758), in Pinus yunnanensis Franch. forest.

Remarks: This pecies is characterized by its grayish-brown to dark brown-spotted pileus, grayish annulus and relatively large, broadly ellipsoid spores. It differs from A. alauda Corner et Bas (1962) in its larger fruitbodies and the larger, broadly ellipsoid spores;from A. pseudoporphyria Hongo (1957) in its spotted pileus, grayish annulus, larger spores and thinner subhymenium. Corner and Bas (1962) emphasized the presence of dark brown hyphae embeded in a gelatinous matrix in the upper layer of the pileipellis of A. alauda. Such hyphae were not observed in A. yuaniana. The thick cuticle calls to mind A. elephas Corner et Bas (1962), but the latter has white annulus, significantly smaller and differently shaped spores, and thicker subhymenium. Furthermore, A. fuliginea Hongo seems to be worth mention with relation to A. yuaniana, from which it differs by its relatively smaller basidiocarps, fuliginous pileus, and globose spores (Hongo, 1953; Imazeki, Otani and Hongo, 1988). A. yuaniana is said to be edible. According to Mr. Yuan, it is sold at the free markets of Miyi and Puge.

It is tentatively assigned to Sect. Phalloideae (Fr.) Quel. (Corner and Bas, 1962; Bas, 1969), which includes several deadly poisonous species.

Distr.: known only from SW Sichuan.

Fig. B. Amanita yuaniana (HKAS 18383): 1. basidiocarp, 2. spores, 3. hymenium and subhymenium, 4. elements of annulus, 5.stipe context


B
2 cm
1
2
15 μm
3
20 μm
40 μm
4
5
40 μm

ACKNOWLEDGEMENTS

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TOLYPOSPORIUM RESTIONUM COMB. NOV. ON *ALEXGEORGEA* SPECIES (RESTIONACEAE) IN WESTERN AUSTRALIA

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The smut of *Alexgeorgea nitens* previously described as *Uredo restionum* Nees is redescribed and transferred to *Tolyposporium* as *T. restionum comb. nov.*. The smut of *A. subterranea* is also described and identified as belonging to *T. restionum*.

The smut of *A. nitens* and *A. subterranea* is identified as belonging to the genus *Tolyposporium* on the basis of spore ball characteristics, including unity, number of teliospores per spore ball and germination behaviour. A more detailed description than Nees provided is given for the fungus, including disease symptoms, teliospore morphology and germination behaviour.

INTRODUCTION

Smut fungi were reported by McAlpine in 1910 on rush (Restionaceae) species from eastern Australia including, *Tolyposporium lepidoboli* McAlp. on *Lepidobolus drapetocoleus* F. v. M. and *Thecaphora leptocarpi* Berk. on *Leptocarpus tenax* R. Br.. Although overlooked in McAlpine's review, the first record of a smut in Western Australia occurred even earlier, in 1846. Nees (1846) discovered a pathogen on a rush and incorrectly named it *Uredo restionum* Nees. The host was incorrectly described as *Restio nitens* because the infected spikelets were enlarged and resembled the female inflorescences of *Restio* species (Johnson & Briggs, 1986). Non-smutted plants were subsequently described as *Alexgeorgea arenicola* by Carlquist in 1976. Finally Johnson & Briggs (1986) realised the two taxa were conspecific and combined the taxa as *Alexgeorgea nitens* (Nees) L. Johnson & B. Briggs.

During an extensive study of Western Australian rushes in recent years (Meney, Dixon, Pate & Dixon, 1990*b*), smut infections on many more native rushes, including *Alexgeorgea subterranea*, have been encountered. Currently, the taxonomic status of *Alexgeorgea* smuts has not been resolved and the morphology and etiology of these smuts are unknown. The smuts of both *A. nitens* and *A. subterranea*, described in this paper, were tentatively listed by Shivas (1989) as *Tolyposporium* species based on teliospore and spore ball morphology and McAlpine's description of the genus in 1910 (Shivas, pers. comm., 1990).

Rushes are widespread and abundant in the south west of Western Australia (Meney *et al.*, 1990*b*). The morphology and phenology of *Alexgeorgea* species has been described by Meney, Pate & Dixon (1990*a*). Plants are extensively clonal on deep sands, with *A. nitens* a fire resprouter and *A. subterranea* an obligate seeder. North of Perth the two species are sympatric, dioecious and produce female flowers which are subterranean and sessile with only their stigmas emergent above ground. *A. subterranea* flowers annually in spring whereas *A. nitens* rarely produces female flowers.

Concepts on the taxonomy of the smut fungi has evolved over the years but according to Fischer & Holton (1957) and Ingold (1989) it should include features such as host specialisation, teliospore morphology, symptomatology and germination type. Type of germination, however, has become the only reliable method of classifying smuts to genus level and has been emphasised in the studies of Ingold (1983, 1985, 1987,1989).

This paper presents findings of a study of the smuts of *A. nitens* and *A. subterranea*, two endemic *Alexgeorgea* species from Western Australia and provides a description of a new smut taxon as part of a larger and ongoing study of smuts affecting Restionaceae and Cyperaceae in Western Australia.

MATERIALS AND METHODS

The smuts of the following rushes were studied: *Alexgeorgea nitens* (Nees) L. Johnson & B. Briggs; *A. subterranea* Carlquist.

Smutted *Alexgeorgea* material was collected from natural stands at locations in the south west of Australia in May 1992. Whole plants of *A. nitens* were recovered from locations at South Perth and Cataby, potted and maintained in a glasshouse for analysis of freshly smutted material. Smutted specimens of *A. subterranea*, from Cataby, were observed in September 1991 and material for diagnosis was collected from old inflorescences in May 1992.

Symptoms of smut infection were recorded by comparison of smutted and non-smutted host inflorescences. Soral features were studied using glycol methacrylate (GMA) resin sections of smutted inflorescence.

Fresh smut sori were examined using light microscopy (LM) and scanning electron microscopy (SEM). Teliospores were observed using LM at 400X magnification in a drop of lactophenol cotton blue mountant. Slight pressure was applied to the slide coverslip to disperse sori for teliospore and spore ball observations. Spore ball unity was determined by the ease of spore ball disintegration occurring during slide preparation. Spore ornamentation and spore ball conformation were observed under SEM. Sori were rubbed lightly between two glass slides, after critical point drying, to disperse spore balls.

Germination was carried out on 1.5 % water agar coated slides incubated at 24^{o}C. A more detailed description of the observation methods mentioned above is given in Websdane *et al.* (1993).

RESULTS

Smut on *Alexgeorgea nitens*

Sori are formed in all spikelets of inflorescences of infected male plants, replacing anthers (Fig. 2) and giving the spikelets a swollen, tear-drop appearance (Fig. 1a & b). These spikelets differ from the tufted appearance of healthy spikelets (Meney *et al.*, 1990*a*). The sori are granular becoming powdery at maturity with globose to elongated, often irregular spore-balls, 38.5-78.5 x 44.0-99.0 µm, which are firmly united and composed of 50 to 100 or more teliospores (Fig. 3a & c). The teliospores are pale yellow-brown, 7.0-14.5 x 9.0-19.0 µm and globose to sub-globose often angular due to compression within the spore ball (Fig. 3b). The teliospore wall is smooth and 1.0-2.5 µm thick. Germination of several teliospores per spore ball occurs after 2-3 days on 1.5 % water agar, producing septate promycelia which give rise to hyphae. The hyphae produce short, sterigmata-like branches at the septa, bearing 1 to 4 basidiospores measuring 2.0-3.0 x 3.5-4.0 µm. Basidiospores are round at first and later elongate and taper at the base.

Smut on *Alexgeorgea subterranea*

Soral, spore ball and teliospore characteristics are identical to those of the smut on *A. nitens* (Figs. 1c & d, 3d-f) although spore ball size is slightly smaller (29.0-69.0 x 39.0- 86.5 µm), teliospore size varies slightly (7.0-15.0 x 8.5-18.5 µm) and walls are thicker (1.0- 3.5 µm). Germination details are identical to those of the smut on *A. nitens*.

Nees (1846) described *Uredo restionum* on *Restio nitens* as follows: "Sporarum globulis subrotundis atris cavum ovarii indurescentis rostratique clausi implentibus."

From this brief description the fungus cannot be identified with certainty. Regarding the host plant, Johnson & Briggs (1986) recombined it with *Alexgeorgea arenicola* Carlquist as *Alexgeorgea nitens*.

This fungus, at least the isotype (MEL 14779), appears identical in symptoms and spore ball morphology to that described on *A. nitens* (Fig. 3g). Although the generic name of Nees' fungus is incorrect there is no doubt that *Uredo restionum* and the smut of *A. nitens* are the same fungus. J. Walker, on a label attached to the sheet of the isotype, in the National Herbarium of Victoria, Melbourne (MEL), on 19.X.1991 wrote: "This smut does not belong in the genus Uredo (a genus of rust fungi)".

Therefore, it is proposed that the smut of *A. nitens* be allocated to a new combination within *Tolyposporium*, called *Tolyposporium restionum,* based on teliospore and spore ball morphology, germination type and host specialisation at the family level. Based on these characteristics, the smut of *A. subterranea* also belongs to this taxon.

Tolyposporium restionum (Nees) Websdane, Sivasithamparam, Dixon & Meney ***comb. nov.***

Basionym: *Uredo restionum* Nees, in Lehmann, Pl. Preiss. Enum. 2:59 (1846).

Type on *Restio nitens* Nees (=*Alexgeorgea nitens* (Nees) L. Johnson & B. Briggs), Australia, Western Australia, Bassendean. Distr., near Perth, XI. 1839, Coll. L. Preiss (no. 1696; MEL 14779).

Sori granulati pulverei fientes; globi sporarum globosi aut extensi, 29.0-78.5 x 39.0-99.0 µm, firme connexi; sporae pallidae, fulvae, globosae, 7.0-15.0 x 8.5-19.0 µm, tunica laevibus, 1.0-3.5 µm crassae; *Alexgeorgeam nitentem* contaminat.

Sori granular becoming powdery at maturity, in all spikelets of inflorescences of infected male plants, replacing anthers and giving the spikelets a swollen, tear-drop appearance rather than the tufted appearance of healthy spikelets. Spore balls globose to elongated 29.0-78.5 x 39.0-99.0 µm, firmly united, composed of 50 to 100 or more teliospores. Teliospores 7.0-15.0 x 8.5-19.0 µm, globose to sub-globose, often angular due to compression within spore ball, pale yellow-brown with smooth walls 1.0-3.5 µm wide. Germination occurs after 2-3 days on 1.5 % water agar. Several teliospores from each spore ball develop tenuous septate promycelia (Fig. 4a) which germinate directly giving rise to hyphae (Fig. 4b & c). The hyphae produce short sterigmata-like branches at the septa, bearing 1 to 4 basidiospores (Fig. 4d-f) measuring 2.0-3.0 x 3.5-4.0 µm. Basidiospores are round at first and later elongate and taper at base.

On Restionaceae: *Alexgeorgea nitens* and *A. subterranea*.

This taxon is most similar to *Tolyposporium muellerianum* (Thuem.) McAlp.; their common features being smooth teliospores and soral production in host spikelets. They are different, however, when host specialisation at family level is considered, as the new taxon infects a member of Restionaceae while *T. muellerianum* infects a member of Cyperaceae.

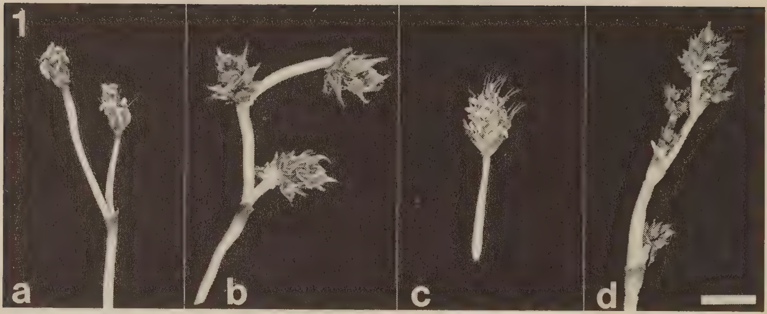


Fig. 1. Symptoms of smut infection in male inflorescences of *Alexgeorgea* spp. Healthy a) & smutted b) inflorescences of *A. nitens*; healthy c) & smutted d) inflorescences of *A. subterranea*. Note that smutted inflorescences do not produce anthers (Bar = 5mm).

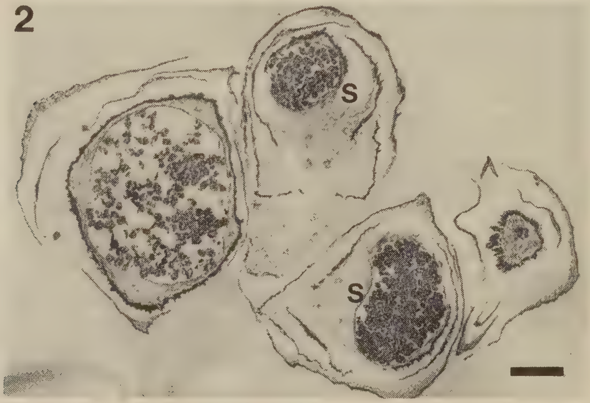


Fig. 2. Transverse section of a smutted inflorescence of *A. nitens* showing sori (S) where anthers would normally develop (Bar = 360µm).

Fig. 4. Germination patterns of spore balls of *T. restionum* on 1.5% water agar. (a) septate promycelia, (b) promycelia giving rise to branched hyphae, (c) production of basidiospores on short unbranched hyphae (Bar = 33µm), (d) production of 1-4 basidiospores on branched sterigmata-like structures, (e) basidiospore dehiscence, (f) lateral & terminal production of basidiospores on septate hyphae (Bar = 7µm).

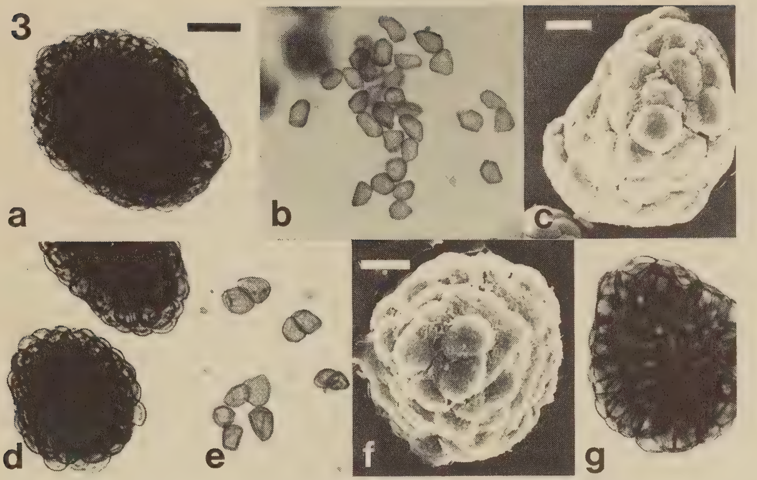
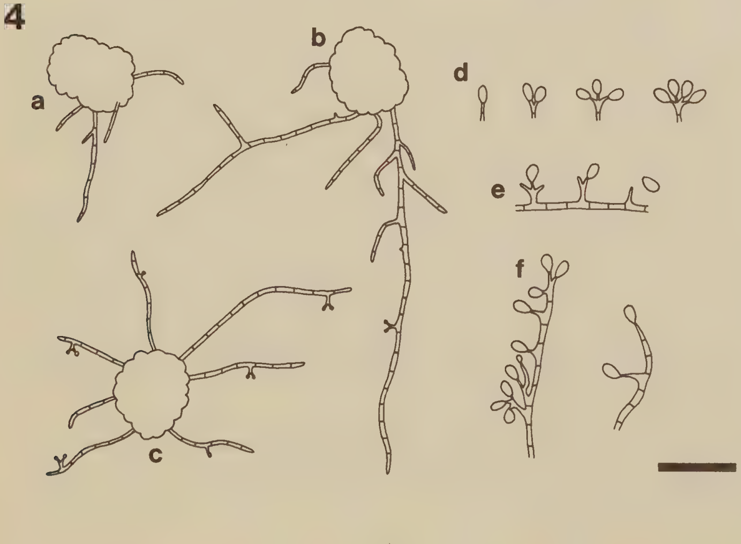


Fig. 3. Spore and spore ball morphology viewed under light microscopy (LM) (Bar = 25μm) and scanning electron microscopy (SEM) (Bars = 10μm). (a) spore ball, (b) spores (LM) & (c) spore ball (SEM) of *A. nitens* ; d) spore balls, e) spores (LM) & f) spore ball (SEM) of *A. subterranea* & g) spore ball (LM) of the smut *U. restionum* (=*T. restionum*) on *R. nitens* (=*A. nitens*) taken from 1839 collection of Nees.



DISCUSSION

The type species for the genus *Tolyposporium* Woronin, *T. junci*, is described as follows: "Sori on the surface of inflorescences or vegetative parts, forming granular to agglutinated, black spore ball masses. Spore balls composed of few to many, firmly united, usually dark coloured spores. Spore germination after *Ustilago* scheme." (Vánky, 1990).

Although *T. restionum* has an internal sorus in spikelets, all other features noted above are represented by this smut indicating that it belongs to this genus. The other nine species belonging to this genus have internal sori in inflorescences. Six of these species are found in Australia, five of which were described by McAlpine in 1910. *T. lepidoboli* McAlp. was described on *Lepidobolus drapetocoleous* F. v. M., a member of Restionaceae.

According to Vánky (1977) many fungi with spore balls have been included in this genus and have been found later to belong to genera such as *Thecaphora*, *Sorosporium* and *Moesziomyces*. He states that our knowledge of the species which really belong to this genus is poor and needs further study.

The main feature of the genus *Tolyposporium* is the spore ball morphology, such as unity, number of spores per spore ball and colour. According to Duren (1973), spore ball morphology has been the basis for describing a substantial number of genera among smuts. The smuts of both *A. nitens* and *A. subterranea* are placed in the genus *Tolyposporium*, as was listed by Shivas (1989), due to the firmly united spore balls composed of 50 to 100 or more teliospores (Shivas, pers. comm., 1990). Caution should be taken, however, when studying dried older herbarium specimens as the sorus becomes more powdery and spore balls disintegrate readily when disturbed (Websdane, 1990). The smut could, under these conditions, be mistaken for *Sorosporium* which has temporary spore balls. For this reason it is necessary to study fresh samples where possible.

Under light microscopy spore balls appear unified and very dark but the nature of the unity is not apparent. Under SEM, however, the strong unity is clearly evident. All spore balls remained intact even though pressure had been applied to them during specimen preparation.

Duren (1973) stated that exospore ornamentation should figure more prominently in species delimitation of the smut fungi than any other single teliospore character. Only three known *Tolyposporium* species have smooth teliospores like those of the *Alexgeorgea* smut. These are: *T. rodwayi*, McAlp. on *Lepidosperma laterale* R. Br., with smooth teliospores adhering together by dark folds of their membrane; and *T. muellerianum* (Thuem.) McAlp. on *Gahnia radula* Benth. and *Gahnia trifida* Labill., which simply has smooth teliospores (McAlpine, 1910). *T. rodwayi* and *T. muellerianum* are also similar in that they are found in host spikelets.

T. muellerianum has the most features in common with the new smut. Its host, however, is a member of Cyperaceae while the hosts of the smuts described here belong to Restionaceae. Fischer & Shaw (1953) realised the importance of host specialisation at host-family level for delineation of smut species and therefore, *T. muellerianum* and the smut of *Alexgeorgea* species should be considered different taxa.

The germination type of *Alexgeorgea* smuts appears to be unique due to the production of basidiospores on short sterigmata-like branches. However, they still possess the general *Tolyposporium* characteristics of a septate promycelium with basidiospores borne at the septa.

The two *Alexgeorgea* species flower six months apart, *A. nitens* in March and *A. subterranea* in September. Eight month old remnant inflorescences on *A. subterranea* in natural stands have contained germinable spores. Thus if the two smuts of *Alexgeorgea* are the same taxon then cross-infection is possible between the species of *Alexgeorgea*.

ACKNOWLEDGEMENTS

The authors are grateful to Professor A.J. Kuthubutheen for the pre-submission review of the paper and Dr Kálmán Vánky for helpful discussion and essential advice on smut nomenclature. The authors would also like to thank Terry Armitage for assistance with photography. This project was supported by the Minerals and Energy Research Institute of Western Australia (MERIWA), RGC Mineral Sands Pty Ltd and Tiwest Pty Ltd.

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MYCOTAXON

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A NEW SPECIES OF TRAMETES FROM PAPUA NEW GUINEA

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Abstract : *Trametes demoulinii* from Papua New-Guinea is described as new. The new taxon is closest to *Trametes conchifer* and *Trametes membranacea*, both from America and *Trametes cingulata* known in Africa and East Asia.. In addition to basidiomata, cultural characters of the new species are described.

Trametes demoulinii G. Castillo, sp. nov.

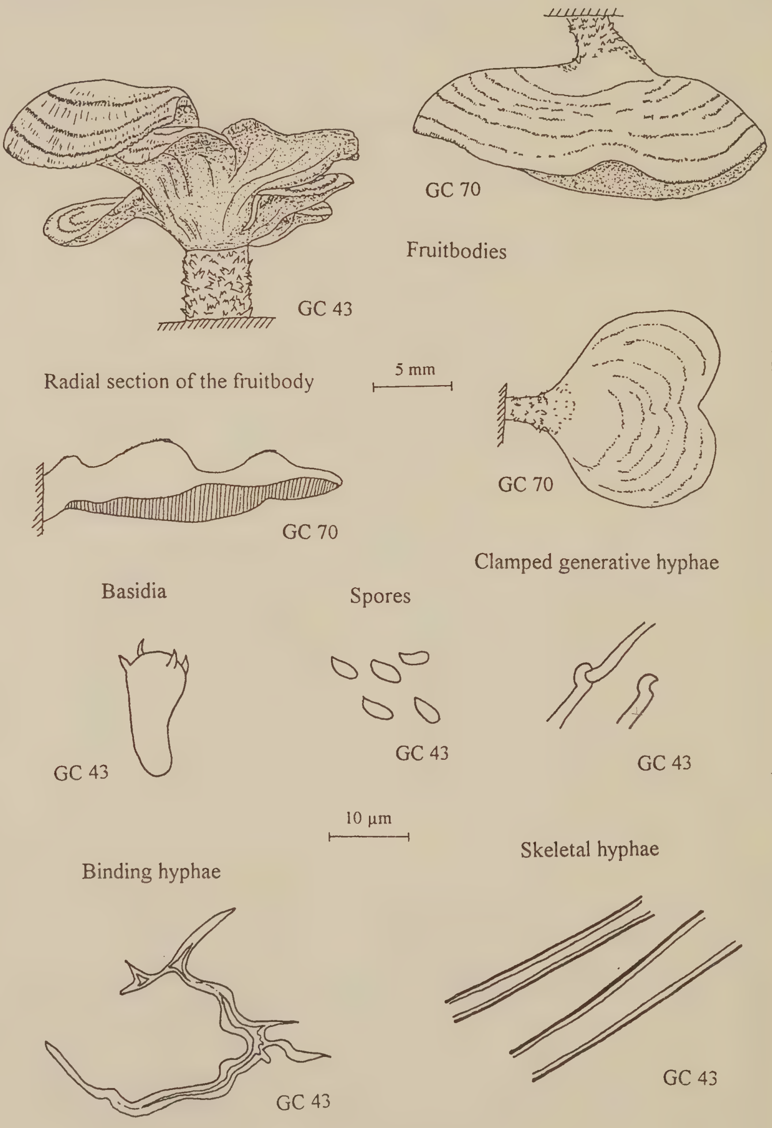
> Pilei usque ad 60 mm longi, dimidiati, flabelliformi ad lateraliter aut ad centrum stipitati, vel ad pilei centrum stipitati et pendentes. Stipites ad 7 mm longi et ad 5 mm lati, squarrosi, nonnumquam basi connati. Pilei glabri, in vivo albi, in sicco coffeati cremei, modice concentrice zonati; margo tenuis, undulatus vel modice incisus. Caro usque ad 2.5 mm crassa, alba vel cremea. Tubi ad 2 mm longi, pileo concolores. Pori : (4) 5-6 (7) / mm, angulati, dissepimentis modice laceratis usque ad denticulatis. Hyphae albae trimiticae, non incrustatae nec dextrinoideae. Skeletales 2.9-7.8 µm latae, pariete minus vel valde incrassato. Ligativae 1.5-3.5 µm latae, laxe ramosae, numerosae. Generatricales 2.0-2.8 µm latae, fibulatae. Setae in hymenio nullae. Sporae albae, laeves, late ellipsoideae, inamyloideae, 4.8-5.2 x 3.0-3.5µm.

Holotype : PAPUA NEW GUINEA, Madang Province, Hansa Bay, Laing Island, 4°10'S, 144°52'E, sea level, on dead decorticated wood of *Terminalia catappa* L., G. Castillo 43, 30 March 1993. LG. Isotypes; GENT, LAE and O.

Basidiocarp annual, flabelliform, applanate-dimidiate to stipitate; when stipitate, stipe lateral or more or less central, squarrulose and may reach 7 mm in length and 5 mm in width; the pendent specimens usually with a dorsally stipe-like attachment (see GC 70). Fruitbodies are sometimes interconnected at the base and may reach up to 6 cm in length. The pileus is glabrous, white on fresh specimens and becomes cream to white coffee, even ochraceous, on exsiccata, sometimes with brownish concentric zones. The margin is thin and lightly denticulate in the old specimens. The specimens have a heavy fungic smell. The context is white-cream and up to 2.5 mm thick.

Pore surface white to ochraceous on exsiccata. Tubes concolorous with the context, up to 2 mm deep, (4) 5-6 (7) pores per mm, pores angular, with dissepiments lightly lacerate to dentate.

Trametes demoulinii sp. nov.


GC 70
Fruitbodies
GC 43
Radial section of the fruitbody
5 mm
GC 70
GC 70
Clamped generative hyphae
Basidia
Spores
GC 43
GC 43
GC 43
10 µm
Skeletal hyphae
Binding hyphae
GC 43
GC 43

Hyphal system trimitic : generative hyphae thin walled, hyaline and with clamps, 2.0-2.8 µm wide, usually disarticulating at cross-walls. Skeletal hyphae hyaline, moderately to very thick walled, from 2.9 to 7.8 µm wide. Binding hyphae hyaline, thick walled, richly branched, 1.5-3.5 µm wide.

Hymenium smooth, cystidia lacking. Basidia clavate with 4 sterigmata and basal clamp, 9.0-12.2 x 4.0-4.6 µm.

Spores hyaline, smooth, thin walled, non-amyloid, oblong-ellipsoid, 4.8-5.2 x 3.0-3.5 µm (in Melzer reagent from spore-print).

Phenology and ecology : White-rotting fungus. All specimens were collected at the end of the rainy season and found on dead *Terminalia catappa* except for GC 70 and GC 73 which were collected on indeterminate fallen branches.

Specimens examined

PAPUA NEW GUINEA, Madang Province, Hansa Bay, Laing Island, 4°10'S, 144°52'E, sea level : G. Castillo 43 : 30-3-1993, on decorticated dead branch of *Terminalia catappa*; G. Castillo 55 : 31-3-1993, on stub of *Terminalia catappa;* G. Castillo 57 : 31-3-1993, on decorticated trunk of *Terminalia catappa*; G. Castillo 70 : 2-4-1993, on small, very decorticated branch on the ground; G. Castillo 73 : 2-4-1993, on decorticated branch; G. Castillo 81 : 4-4-1993, on very decorticated branch of *Terminalia catappa*.

Description of the mycelium in culture : G. Castillo 43 (Description after one week on malt-agar).

Macroscopic characters : Around the inoculum the aerial mycelium is white, thin and dense. Afterwards, it becomes white, fibrous and strongly applied on the agar. Marginal hyphae loose, hyphae applied on the agar.

Microscopic characters : Marginal hyphae : generative hyphae hyaline, thin walled, simply septate to clamped, very long, sparsely branched, 2.0-5.0 µm wide.

Aerial mycelium : generative hyphae hyaline, thin walled, simply septate to clamped, very long, sparsely branched, 2.0-4.0 µm wide. Skeletal hyphae hyaline, thin to thick walled, 2.5-4.5 µm wide. Binding hyphae rare, hyaline, thick walled with main trunk and branches.

Submerged mycelium : generative hyphae hyaline, thin walled, simply septate, 1.0-4.0 µm wide.

Oxidase test : Positive result with guaiacol (laccase and peroxidase, as confirmed by gel electrophoresis) and p-cresol (tyrosinase).

Code according to Nakasone (1990) : 2, 3i, 7, 32, 36, 38, 41, 51, 54.

Remarks

Our specimens do not correspond with any species so far described in the genus *Trametes* [Cunningham (1965), Ryvarden (1978), Corner (1989 and 1991), Ryvarden & Johansen (1980), Gilbertson et Ryvarden (1987), Nihoul (1991) and Quanten (1993)]. The new species is closely related with *Trametes membranacea* (Sw. : Fr.) Kreisel from which it differs however by the spore size. The spores of the latter are 4.5-6.0 x 2.0-2.5 µm in size (Gilbertson & Ryvarden 1987) whereas those of *T. demoulinii* are broader, 4.8-5.2 x 3.0-3.5 µm. Another morphologically similar species is *T. conchifer* (Schw.) Pilát. It differs from *T. demoulinii* by the smaller fruitbodies and by the number of pores per mm (2-4 pores / mm against (4) 5-6 (7) pores / mm in *T. demoulinii*) (Gilbertson et Ryvarden 1987). *Trametes cingulata* Berk. is microscopically similar to our species but becomes darker and never presents a squarrulose stipe [Ryvarden and Johansen (1980) and Ryvarden (pers. comm.)]. An interesting feature of this species is that it was collected several times in March-April 1993 but never before that despite the fact that polypores have been intensively collected on Laing Island since 1980. The polypores of the area have been treated in three unpublished theses : Nihoul (1991), Castillo (1993) and Quanten (1993). Indeed, according to many mycologists several tropical polypores fruit only occasionally and still remain to be discovered.

Acknowledgements

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MYCOTAXON

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OMNIDEMPTUS AFFINIS GEN. ET SP. NOV., TELEOMORPH OF MYCOLEPTODISCUS AFFINIS SP. NOV.

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> *Omnidemptus* is described as a new monotypic genus of ascomycetes, and shown to have as its anamorph a new species of the hyphomycete genus *Mycoleptodiscus*.

A fungus belonging to an undescribed genus of the Ascomycota, with an anamorph identified as a new species of *Mycoleptodiscus* Ostazeski, was isolated from the grass *Panicum effusum* R.Br. in 1990. The teleomorph is named *Omnidemptus affinis* gen. et sp. nov., and the anamorph *Mycoleptodiscus affinis* sp. nov. Ascomata were formed sparingly in a sub-culture of the primary isolate grown on Sachs' agar + maize leaf to induce anamorphic sporulation. Spore suspensions containing ascospores or conidia were streaked onto tap water agar and incubated at 25°C overnight. Single-ascospore and single-conidium cultures were established from germinated spores, with each spore examined at high magnification (x 400) prior to transfer. Ascomata and conidiomata were formed in each of six ascosporic and two conidial cultures, confirming the anamorph-teleomorph connection.

Omnidemptus affinis P. Cannon & Alcorn, gen. et sp. nov. (Fig. 1)
Etym.:(L.) omnis - all, et demptus — taken away, for generic resemblance to take-all fungi.
Ascomata superficialia, perithecia, 145-205 μm diam, pyriformia, collo 100-250 μm, dense hirsuto. Peridium texturae angularis composito, cellula fusca 6-10 μm diam. Paraphyses 3-6 μm diam, tenuitunicati. Asci 54-68 x 10-13 μm, cylindrico-clavati, brevistipitati, octospori, apex obtusus, poroidis, cum annulo caerulescenti in iodo. Ascosporae 24.5-33 x 4-5.5 μm, tenuifusiformes, parte centrali tumescenti, uni- vel triseptatae, hyalinae.
Ex foliis *Panici effusi* var. *effusi*, Stony Creek State Forest, Queensland, Australia, 19 May 1990, V.P. Cooper 12c, BRIP 17195 culturae siccae holotypus, IMI 353435 culturae siccae et lyophilisati isotypus. Anamorphosis *Mycoleptodiscus affinis* Alcorn & P. Cannon sp. nov.

Ascomata ± superficial on plant material in culture, perithecia, 145-205 μm diam, ± pyriform, with a neck 100-250 μm long, which is 80-110 μm diam at the base and tapering gradually to 40-60 μm at the apex, ostiolate. *Peridium* composed of several layers of dark brown fairly thick-walled angular cells 6-10 μm diam, the body ± glabrous but the neck darker brown, composed of hyphal cells rarely more than 2 μm diam, and densely hairy, the hairs to 60 μm long, hyaline to pale brown, mostly aseptate, sometimes slightly inflated and occasionally becoming dark brown, thicker- and slightly rough-walled, with an apical conidiogenous locus. *Periphyses* not seen (but probably obscured). *Paraphyses* 3-6 μm diam, very thin-walled, septate, sometimes deliquescing at maturity. *Asci* formed from a crozier system, 54-68 x 10-13 μm, cylindric-clavate, short-stalked, sometimes evanescent at the base, fairly thick-walled but without discernible layers, the apex obtuse, with an apical pore 2-3 μm diam and *ca* 4 μm deep, with a small ring at the base which stains dark blue in Melzer's reagent; usually 8-spored but not infrequently 4-spored. *Ascospores* arranged biseriately, 24.5-33 x 4-5.5 μm, at first narrowly fusiform, sometimes with the ends slightly swollen, the central portion usually swelling into a ± ellipsoidal central bulge;

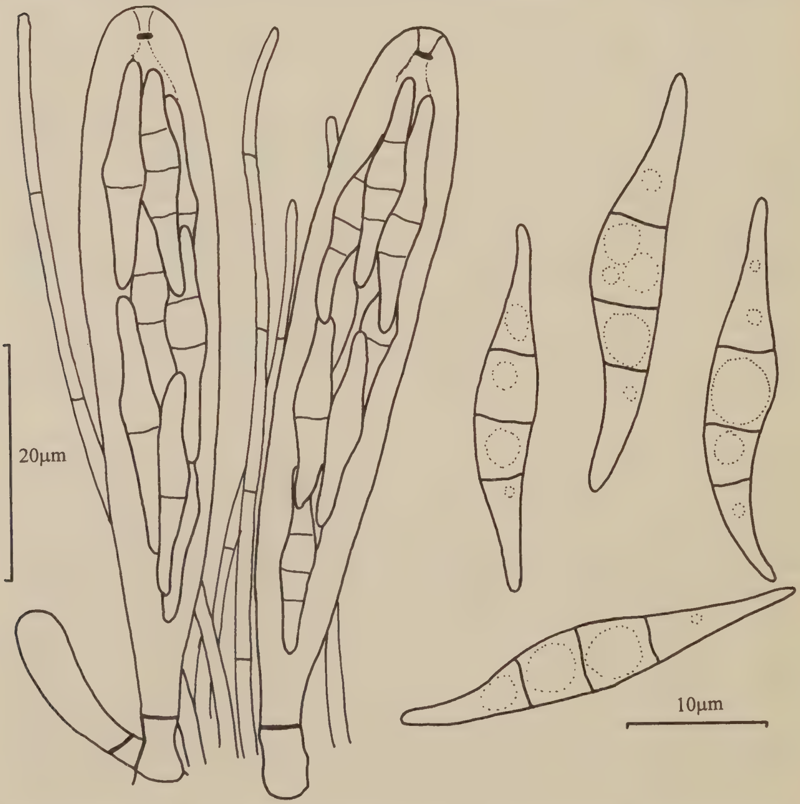

Fig. 1. *Omnidemptus affinis.* Asci, paraphyses and ascospores.

usually becoming 1- or 3-septate, the median septum usually placed slightly below the widest point; thin-walled, hyaline, without gelatinous sheaths or appendages.

Mycoleptodiscus affinis Alcorn & P. Cannon, sp. nov. (Fig. 2)
Etym.:(L.) affinis — allied to, for its similarity to *M. lunatus*.
Hyphae hyalinae vel pallide brunneae, septatae, 2-5.5 µm diam. Conidiomata medio vel atrobrunnea, sporodochialia, e cellulis conidiogenis aggregatis composita, usque ad 160 µm diam. Cellulae conidiogenae discretae vel in conidiomatibus aggregatae, ampulliformes 7-12 µm diam vel elongatae 11-22 x 6-10 µm, atrobrunneae, laeves, collo distincto et apertura 2-3 µm diam. Conidia hyalina, falcata, guttulata, 1- 2 (-3) septata, plerumque asymmetrice 2 septata, 21-30 x 3-4 µm.
Ex foliis *Panici effusi* var. *effusi*, Stony Creek State Forest, Queensland, Australia, 19 May 1990, V.P. Cooper 12c, BRIP 17195 culturae siccae holotypus, IMI 353435, culturae siccae et lyophilisati isotypus.

Hyphae in culture hyaline to pale brown, smooth, septate, 2-5.5 µm diam. Conidiomata varying from one conidiogenous cell up to irregularly shaped aggregations 50-160 µm diam. Conidiogenous cells dark brown, ampulliform and 7-12 µm diam or elongated, cylindrical, clavate or ellipsoid, 11-22 x 6-10 µm, rounded to somewhat angular in face view, smooth, with a circular aperture 2-3 µm diam enclosed by a cylindrical to flared collarette 3-4 µm diam. Conidia hyaline, falcate, 1- 2 (-3) septate, commonly asymmetrically 2-septate with the first septum median and the second in the upper half, occasionally in the lower half, thin-walled, guttulate, smooth, bluntly pointed at the extremities, the base sometimes with an abrupt change in contour to a short pedicel-like extension, lacking polar or lateral appendages, 21-30 x 3-4 µm. Appressoria developed by germinating conidia under coverslips on 0.5% sucrose water agar are mid olivaceous brown, smooth, with outline entire or usually moderately to deeply lobed, 7.5-14 x 5-8.5 (-11) µm and with the germ pore ca 1.8 - 2.0 µm diam.

The only other *Mycoleptodiscus* species in which conidial appendages are absent is *M. lunatus* B. Sutton & Alcorn. That species can be distinguished from *M. affinis* by its medianly 1-septate conidia which generally taper gradually towards the base (Sutton & Alcorn 1985), whereas in *M. affinis* conidia are narrowed more or less abruptly at the extremities and commonly are 2-septate. In addition they are slightly narrower than those of *M. lunatus*. Conidial septation was further compared in cultures grown at the same time under identical conditions, on Sachs' agar + maize leaf. In *M. lunatus*, 98% of conidia were medianly 1-septate, the remainder being 2-septate with the second septum in either the upper or lower half. In contrast ca 75% of *M. affinis* conidia were 2-septate, with most of the remainder 1-septate. Conidia with three septa occurred rarely. Appressoria of *M. lunatus* are slightly darker than in *M. affinis*, angular-obovoid with margins entire or irregular with blunt lobes, occasionally clavate, fusiform or ± cylindrical, 7-12 x 5-8 µm, germ pore ca 0.8-1.5 µm diam.

The affinities of *Omnidemptus* most probably lie with *Magnaporthe* Krause & Webster and its relatives *Buergenerula* H. Sydow, *Gaeumannomyces* von Arx & Olivier and *Clasterosphaeria* Sivanesan. Similarities include almost all ascomatal and ascus features, the presence of appressoria, and a strong host preference for non-petaloid groups of the Liliophyta (monocotyledons). Most of these genera have fruit bodies

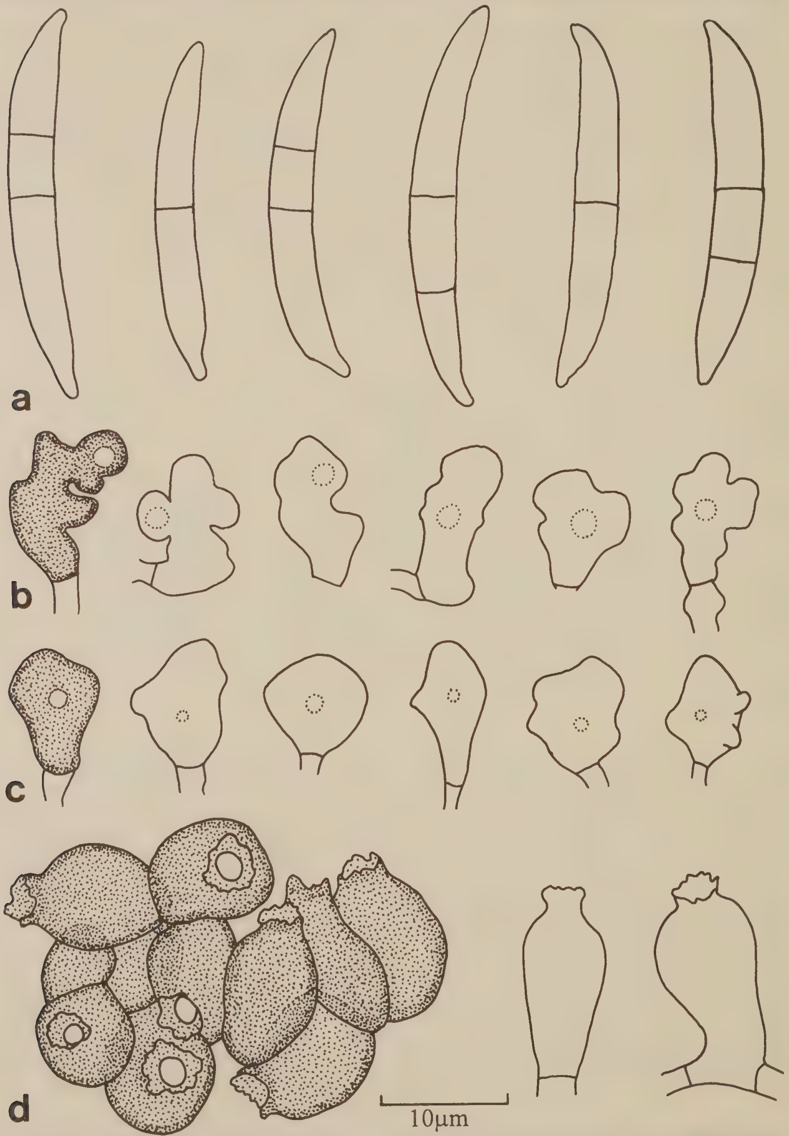

Fig. 2 a, b, d. *Mycoleptodiscus affinis*. a: conidia b: germ tube appressoria d: conidioma and conidiogenous cells. 2 c: *M. lunatus* germ tube appressoria.

which are immersed in the substrate, but that is not considered here to be particularly important in the assessment of relationships, particularly as *Omnidemptus* is known developed only on plant material in culture, rather than on directly-collected host material. *Magnaporthe* itself differs from *Omnidemptus* primarily in ascospore pigmentation, constituent species having spores with brown central cells.

One of the most distinctive features of *Omnidemptus* is its anamorph, referable to *Mycoleptodiscus*. At first sight, this looks dramatically different from the anamorphs of *Magnaporthe* and its relatives. This group already has anamorphs which are morphologically diverse, and on more intensive examination *Magnaporthe* itself may be revealed as polyphyletic. Some species of *Magnaporthe,* and at least most members of *Gaeumannomyces,* have *Phialophora*-like anamorphs producing curved conidia, so the strongly pigmented conidiogenous cells found in *Omnidemptus* are not totally novel in the group.

Mycoleptodiscus-like structures are seen in hyphal aggregations formed by *Magnaporthe rhizophila* Scott & Deacon (1983), *M. poae* Landschoot & Jackson (1989) and *Gaeumannomyces graminis* (Sacc.) von Arx & Olivier (Walker, 1980: 107). The dense clusters of hyphopodia seen in some species of *Gaeumannomyces* may be developmentally similar to the proliferating groups of conidiogenous cells in *Mycoleptodiscus.*

A further paper discussing the interrelationships of this group of fungi is in preparation.

We are grateful to V.P. Cooper for the collection which yielded this interesting fungus, to Dr M.E. Barr Bigelow for her advice to J.L.A. on the possible identity of the teleomorph, to Prof. D.L. Hawksworth for comments on the manuscript, and to Prof. A.J. Kuthubutheen for pre-submission review.

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MYCOTAXON

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COLLYBIA GRINBERGSII sp. nov. FROM CHILE

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Abstract.- *Collybia grinbergsii* is proposed as a new species within section *Subfumosae* Singer ex Halling. It is characterized by its basidiocarps with pruinose stipe, amygdaliform to ellipsoid spores and its cheilocystidia which are broadly clavate and smooth or with diverticulate apex.

Key words: *Collybia grinbergsii*, *Agaricales*, Chile, taxonomy, chorology.

Collybia grinbergsii Valenzuela & Moreno, *sp.nov.* (Figs.1-2)

Etymology: in honour of Dr. J. Grinbergs because of his contribution to the progress of mycology in Chile.

Basidiocarpis solitariis vel caespitosis (2-3 carpophoris). Pileo* 10-25 mm *diam., convexo vel plano-convexo, hygrophano, striato-sulcato usque ad dimidium radii, glabro, in humido fusco-cremeo, in sicco ochraceo-griseo erubescenti. Margo decurvato, striato, laeve vel crenulato in aetate, concoloro vel pallidiore. Lamellis subdecurrentibus vel adnatis, subdistantibus, gracilis, cremeis postremo pallide fuscis, acie integro, concoloro. Stipite* 45-60 x 0,5-1,5 mm, *cylindrico parce recurvato, sicco, totus pubescenti, fusco-cremeo, versus apicem concoloro ad lamellis, basim mycelio albo exornatis. Carne minima, cremea, postremo pallide brunnea.

Sporis* 8-10 x 4,5-5,5 µm, *amygdaliformibus vel ellipsoideis, laevis, hyaliniis, inamyloideis nec dextrinoideis. Basidiis* 30-47 x 6-8 µm, *claviformibus, tetrasporis, hyalinis. Cheilocystidiis hyalinis polymorphicis predominti claviformibus,* 30-65 x 10-20 µm, *ceteris subglobosis vel

subventricosis*, 30-70 x 18-30 µm, *apicem* 7-11 µm, *ceteris sparsis cylindricis*, 33-50 x 8-9 µm, *laevis, ver sparse diverticulatis longitudine variabili ad pars apicale. Caulocystidiis* 65-110 x 5-7 (8) µm, *polymorphicis, praecipue cylindricis, hyalinis. Pileipellis ab hyphis cylindricis* 3-10 µm *diam., saepe ramificatis, contortis cum hyphis, diverticulatis, angustis, hyalinis vel cremeis (in* KOH 5%*). Fibulae praesentes.

Basidiomata gregarious to cespitose (2-3 carpophores). Pileus 10-25 mm in diam., convex to applanate-convex, hygrophanous, striate-sulcate up to halfway from margin, glabrous, brown-cream when moist, grey-ochre with pinkish tinges when dry. Margin decurved, striate, smooth to crenulate at maturaty, concolorous to pileus. Gills subdecurrent to adnate, subdistant, thin, cream when young, later very pale-brown, edges entire and concolorous to lamellae. Stipe 40-60 mm long, 0,5-1,5 mm thick, somewhat curved, surface dry, pruinose in its whole length, brown-cream towards the apex, concolorous to lamellae, with white mycelium at the base. Flesh thin, cream to pale-brown. Smell and taste not characteristics.

Spores 8-10 (11) x 4,4-5,5 µm, amygdaliform to ellipsoid, smooth, inamyloid. Basidia 30-47 x 6-8 µm, clavate, 4-spored, hyaline. Cheilocystidia hyaline, smooth or with diverticulate apex, polymorphic, predominantly broadly clavate and 30-65 x 10-20 µm, some of them subglobose to broadly utriform, 30-70 x 18-30 µm, 7-11 µm at the apex; a few rarelly cylindrical, 33-50 x 8-9 µm. Caulocystidia 65-110 x 5-7 (8) µm, polymorphic, predominantly cylindrical, hyaline. Pileipellis consisting of cylindrical repent hyphae, 3-10 µm diam., often branched, contorted, diverticulate, hyaline or with cream contents in KOH 5%. Clamp connections present.

Material examined: *Typus* AH 15545, Rebellín, Valdivia, Chile, *leg.* J. Grinbergs, 13-V-1992, on bark debris on soil in forest of *Nothofagus obliqua-Laurelia sempervirens-Persea lingue* (Roble-Laurel-Lingue). AH 15546, Parque SAVAL, Valdivia, Chile, 31-III-1992, *leg.* S. Garnica & E. Valenzuela, on cones and needles of *Austrocedrus chilensis* (Ciprés de la Cordillera).

Typus deposited at the Herbarium of University of Alcalá de Henares, Department of Plant Biology (AH). *Isotypus* deposited at MA Fungi and NY.

Observations: *Collybia grinbergsii* is characterized by its basidiomata with pruinose stipe, its amygdaliform to ellipsoid spores and its broadly clavate and smooth cheilocystidia that sometimes have a diverticulate apex. Because of its macro- and microscopical characters.

Collybia grinbergsii belongs to section *Subfumosae* Singer ex Halling (HALLING, 1983; SINGER, 1986). Macrospically it is close to *C. tergina* (Fr.)

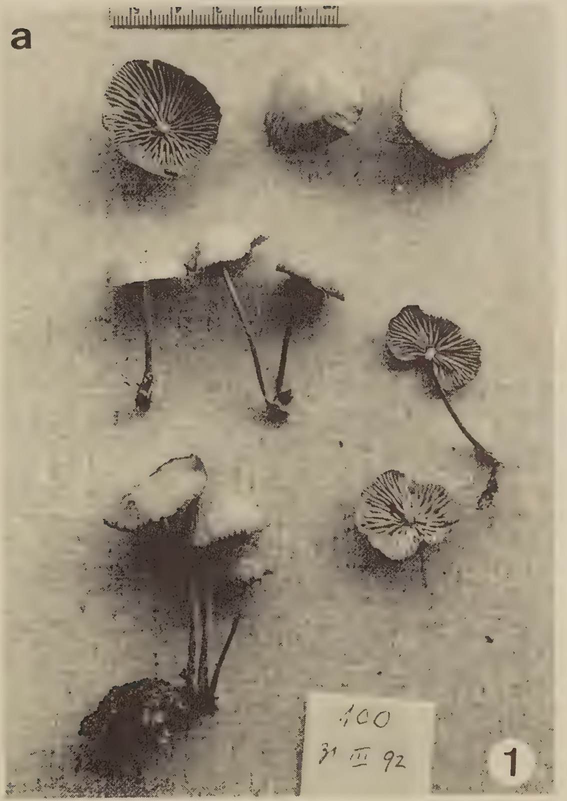
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Fig. 1.- ***Collybia grinbergsii*** **(*typus*)**. a: Carpophores.

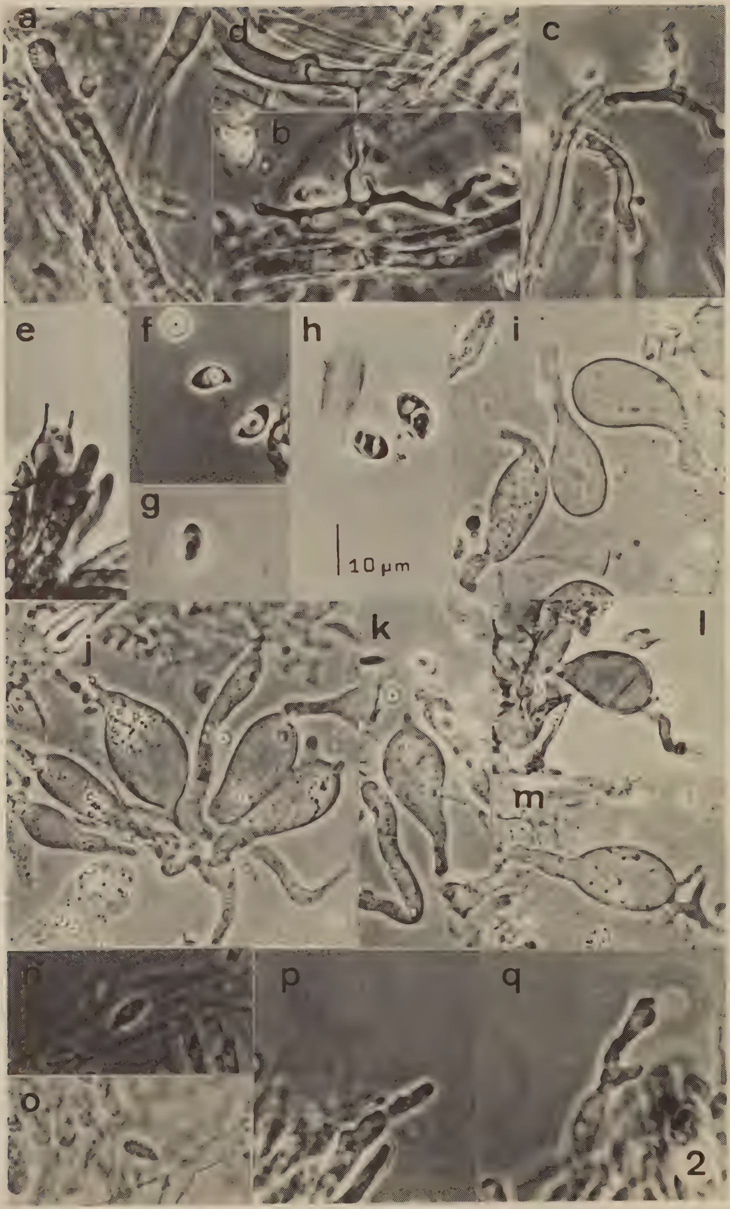
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Fig. 2.- ***Collybia grinbergsii*** **(*typus*)**. a-d: Pileipellis. e: Basidia. f-h: Spores. i-m: Cheilocystidia. ***Collybia tergina*** **(*topotypus* 76/355, IB)**. n-o: Spores. p-q: Cheilocystidia.

Lundell, but differs because the latter shows subcylindric, flexuous-contorted cheilocystidia as well as narrower spores (9.4-11.2 x 3.4.4.6 μm) which are dacryoid to ellipsoid.

We have studied topotypical material (Moser 76/355, IB) and Litten's collections (n° 660 and 1058, FH) of *C. tergina* verifying all the characteristics indicated for this species.

RAITHELHUBER (1987), describes briefly several species of *Collybia* from Argentina, some of them with stipe pruinose as *Collybia rufo-cuprea* Raith., *C. flavomycelina* Singer and *C. tucumanensis* Singer. In all of these species , absent of cheilocystidia were indicated. *Collybia grinbergsii* has abundant and patent cheilocystidia.

GARRIDO (1988), describes three new species of *Collybia* from Chile (*C. cryptocaricola, C. maulensis* and *C. nahuelbutensis*), but they have their stipes smooth and their cheilocystidia are different.

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We wish to express our gratitude to Dr. E. Horak for confirming our material and his scientific comments, and to Dr. M. Heykoop and Dr. Halling for revising the manuscript. To Dr. J.E. Wright for his collaboration in making the latin diagnosis. To the "Agencia Española de Cooperación Internacional de Asuntos Exteriores, Secretaría de Estado para la Cooperación Internacional y para Iberoamérica", for giving a fellowship to one of us (E. Valenzuela) to realize his doctoral thesis. Dr. G. Moreno wishes to express his gratitude to the "Ministerio de Educación y Ciencia, Dirección General de Investigación Científica y Técnica" of Spain for the financial assistance for travel to Argentina, within the "Programa de Movilidad Temporal al Personal Funcionario". This work belongs to the Proyect DID-UACH S-94-01.

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MYCOTAXON

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RAMALINA BALTICA AND RAMALINA CANARIENSIS IN NORTH AMERICA

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ABSTRACT: *Ramalina baltica* Lettau and *Ramalina canariensis* Steiner are reported as new to the flora of North America. *Ramalina baltica* occurs locally in fog zones of central California and *Ramalina canariensis* is a common coastal species which has been misidentified historically. *Ramalina canariensis* has a broad range extending from Baja California Sur to northern California. Phytogeographic considerations are discussed.

INTRODUCTION

This paper continues a series of investigations of the genus *Ramalina* in western North America in the Vancouverian Floristic Province of the Rocky Mountain Region, and extending through the California Floristic Province into northern Baja California (Cronquist 1982).

The complex taxonomy and phytogeography of the genus *Ramalina* in western North America is characterized by the presence of world-wide taxa, Old World and Pacific-Rim disjunctions, and endemics, all of which are elements of the California lichen flora.

The sorediate species of *Ramalina* in western North America have long been a source of confusion to lichenologists. It does not seem unlikely, then, that we confirm the presence of two species, the temperate Old World taxon *R. baltica* Lettau, and the Mediterranean disjunct *R. canariensis* Steiner, that have not been previously reported from North America.

THE TAXA

Ramalina baltica Lettau (Figures 1-2) is a temperate suboceanic taxon previously known from Britain and Europe (Krog and James 1977). This small species is characterized by: (1) lateral and subterminal to terminal vesicular soralia; (2) parietal soredia; (3) the presence of either divaricatic acid or evernic acid races; (4) a ragged, tufted thallus; (5) a corticolous habit.

Ramalina obtusata (Arnold) Bitt. also produces parietal soredia released by terminal swellings (Krog and James 1977) and has often been confused with *R. baltica*. It differs in having a more truly fistulose thallus, a boreal or alpine distribution, a corticolous or saxicolous habit, and contains only evernic acid. *Ramalina canariensis* may also appear similar to *R. baltica* but may be distinguished by its attenuate lobe apices, the generally smooth, matt thallus, and a divaricatic acid chemistry.

In North America *R. baltica* is apparently rare and localized in coastal fog zones in northern Santa Barbara County and in San Luis Obispo County. It grows on the trunks and main branches of oaks and rarely on *Salix* in mature forests. The California collections of *R. baltica* contain divaricatic acid, a chemical race known from western Europe (Krog and James 1977). **Chemistry:** divaricatic acid, ± faint traces of nordivaricatic acid, ± faint traces possible triterpenes.

> **SPECIMENS EXAMINED:** USA. CALIFORNIA. SAN LUIS OBISPO CO.: San Luis Bay, *Riefner 87-17* (BRI, DUKE, SBM, WIS); Morro Bay State Park, *Riefner 90-68* (IRVC); Arroyo Laguna, *Riefner 89-181* (IRVC). SANTA BARBARA CO.: Constellation Rd. at Rte. 1, *Riefner 87-227* (IRVC) and *Riefner 90-208* (DUKE, IRVC).

Ramalina canariensis Steiner (Figures 3-4) was previously thought to occur only in the Mediterranean climate zones of the European Mediterranean basin, the Canary Islands, South Africa, South America, and Australia (Stevens 1987). Its occurrence in the Mediterranean regions of California and Baja Mexico are an interesting addition to its reported range. This small species is characterized by: (1) parietal, often blue-green soredia; (2) a divaricatic acid chemistry; (3) a generally smooth, matt thallus with acute to attenuate lobe apices; (4) the presence of distinct chondroid tissue; (5) an erect to subpendulous corticolous habit.

Historically *R. canariensis* has been misidentified in North American herbaria as *R. evernioides* Nyl. (a European name erroneously applied to *R. lacera* (With.) Laundon; Laundon 1984; Krog and James 1977) and less frequently as *R. subleptocarpha* Rundel and Bowler. *Ramalina lacera* may easily be separated from *R. canariensis* by the unique one-layered cortex, the absence of chondroid tissue, and the content of bourgeanic acid. *Ramalina subleptocarpha* may be distinguished by the typical shallow marginal splitting of confluent soralia, a basal branching pattern, and chemotypes which include zeorin, bourgeanic acid, and an acid deficient race.

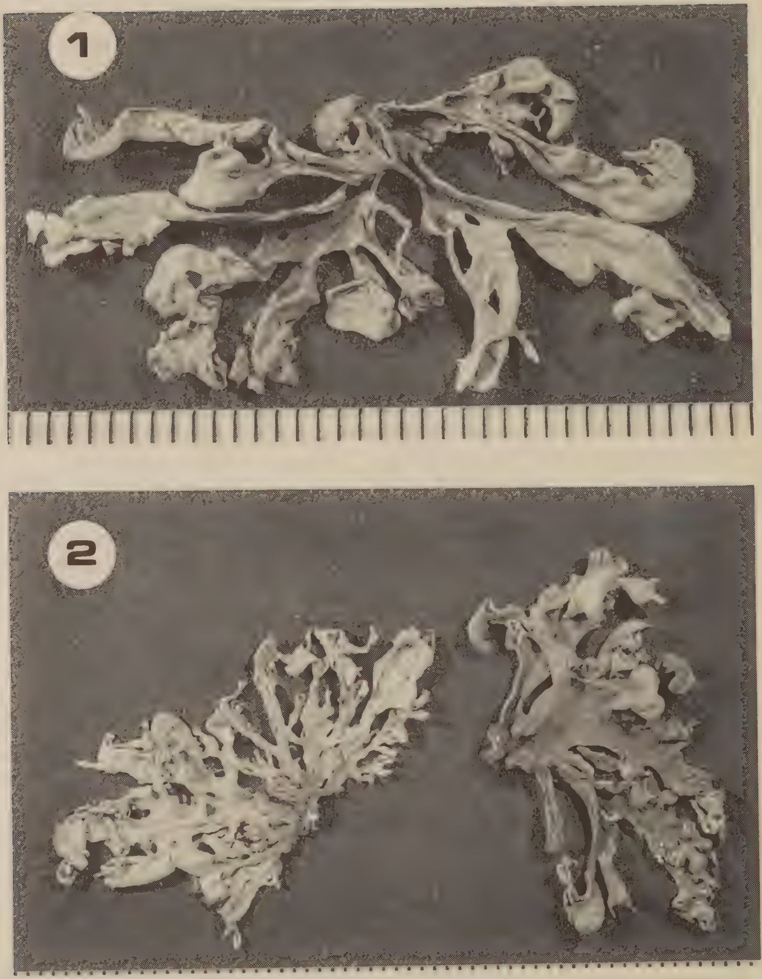
Since the sorediate *Ramalina* species of western North America have been poorly understood, it is not surprising to find that *R. canariensis* has a rather broad North American distribution ranging from Baja California Sur to northern California. This species is often abundant and may form homogeneous swards on tree and shrub branches in open scrub habitats as well as a variety of other coastal phanerogamic communities where it prefers well-lit situations occasionally influenced by mists. **Chemistry:** divaricatic acid, faint traces of nordivaricatic acid, ± faint traces unidentified possible triterpenes, ± usnic acid.

> **REPRESENTATIVE SPECIMENS EXAMINED:** MEXICO. BAJA CALIFORNIA SUR: Guerro Negro, *Roberts s.n.* (IRVC). BAJA CALIFORNIA NORTE: San Quintín, *Roberts s.n.* (IRVC); Punta Santo Tomas, *Riefner and Roberts 89-356* (BRI, IRVC); Punta Banda Peak, *Bowler s.n.* (IRVC); Los Arbrolitos, *Bowler s.n.* (IRVC). USA: CALIFORNIA: LOS ANGELES CO.: Santa Monica Range, *Hasse s.n.* (DH); Pasadena, *Hasse s.n.* (FH); San Clemente Island, *Riefner and Bowler 89-117* (IRVC); Arroyo Seco, *Kingman 988* (FH); San Nicholas Island, *Howell 33* (DH); Santa Catalina Island, *Bratt 4141* (SBM); Santa Catalina Island at Avalon, *Bowler s.n.* (IRVC). MONTEREY CO.: Pt. Lobos Reserve, *Bratt 3751* (SBM); Pt. Lobos Reserve, *Wheeler 4455* (US). ORANGE CO.: Aliso Creek, *Riefner and Marsh 92*-6 (IRVC); Pelican Hill, *Bowler s.n.* (IRVC). SAN DIEGO CO.: San Diego Harbour, *Palmer 286* (US); Torrey Pines Reserve, *Riefner 91-166* (IRVC). SAN LUIS OBISPO CO.: Oso Flaco Lake, *Riefner 87-245* (IRVC, US) and *Riefner 90-1* (CAS, COLO, DUKE, BRI, LAM, FH, IRVC, NY, SBM, US, WIS); Morro Bay, *Riefner 87-455* (IRVC) and *Riefner 85-518* (IRVC); South Bay Blvd. at Los Osos, *Riefner 90-7* (BRI, IRVC, WIS); Avila Beach, *Riefner 86-94* (COLO, IRVC); Montaña de Oro State Park, *Riefner 87-455* (IRVC). SAN MATEO CO.: Santa Cruz Co. line, *Riefner 85-706* (COLO, IRVC). SANTA BARBARA CO.: Santa Cruz Island, *Bratt 1771* (SBM) and *1494* (US); Guadalupe Dune Park, *Riefner 91-51* (IRVC); Santa Lucia Canyon, *Riefner 87-228* (IRVC); Opuntia Nature Trail, *Bratt 5166* (SBM); Santa Barbara, *Calkins 305* (FH). SONOMA CO.: Salt Pt., *Riefner 86-123* (IRVC).

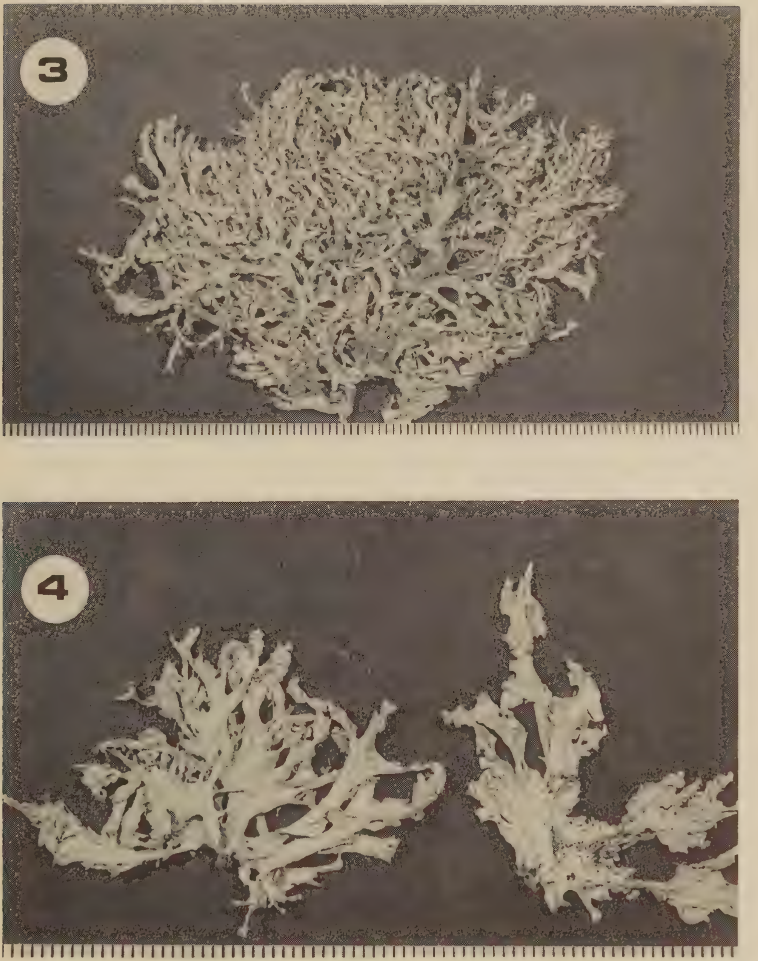
PHYTOGEOGRAPHY

Although sorediate taxa such as *R. baltica* and *R. canariensis* may be disseminated by fortuitous long-distance dispersal of diaspores it is intriguing to consider these disjunctions in relation to plate tectonics and vascular plant migrations by tracing the paleobiogeography and phylogenetic affinities of phanerogams (Sheard 1977, Stevens 1991). Hypothetically, insight might be gained into the origins and migrations of lichen taxa.

California has been identified as an important region in North America for surviving relicts of the temperate Arcto-Tertiary Geoflora (Raven and Axelrod 1978). The floras of north-central Europe, the European Mediterranean basin, and California share in common a number of Neogene woody plants nearly identical to living taxa (Raven 1973, Sauer 1988). Could epiphytic lichens nearly identical to modern taxa have migrated with the close relatives of living woody phanerogams? The occurrence of *R. baltica* in summer fog zones of California may be another example of Tertiary



Figures 1-2. Growth forms of *Ramalina baltica* Lettau. Scale in mm. Fig. 1. Open lax form, *Riefner 90-68* (IRVC). Fig. 2. Cespitose form, lower surface (left), upper surface (right), *Riefner 87-17* (IRVC).



Figures 3-4. Growth forms of *Ramalina canariensis* Steiner. Scale in mm. Fig. 3. Dense form, *Riefner 90-1* (IRVC). Fig. 4. Open form, upper surface (left), lower surface (right), *Riefner 85-518* (IRVC).

persistence previously discussed for other lichen taxa disjunct in North America as a relict of ancestral phanerogamic migrations following the separation of the northern continents in the Tertiary (Riefner 1990).

The widely disjunct occurrence of *R. canariensis* illustrates the numerous phytogeographical questions concerning the origin and dispersal of a single lichen taxon into the remote Mediterranean zones. Portions of the European Mediterranean basin may represent the borders of an inland remnant of the Tethys Sea (Deacon 1983, Read and Watson 1975). Numerous taxa that link Madrean-Tethyan vegetation between California and the Mediterranean are well-documented (Axelrod 1973 and 1975, Kärnefelt 1980, Raven and Axelrod 1978, Tehler 1983). *Ramalina canariensis* does not inhabit distinct mesic refugia influenced by warm-season precipitation as described by Stebbins and Major (1965) and may not be a relict of northern Tertiary forests in North America, although it is common in the European Mediterranean basin (Krog and Østhagen 1980). Did *R. canariensis* evolve along the subhumid shores of the Tethys Sea in association with Madrean-Tethyan vegetation?

In defining a "Mediterranean species" di Castri (1991) concludes that Mediterranean biota form a mosaic of species of different biogeographic origin. Since Mediterranean climates are geologically recent (established in the Plio-Pleistocene period; Raven 1973) and younger than the biotas inhabiting these regions, existing similarities between the floras of the hemispheres could be potentially explained by an ancient pre-drift distribution or episodes of long-distance dispersal. It is likely that the disjunct range of *R. canariensis* in the Southern Hemisphere Mediterranean climates may be attributed to episodes of long-distance dispersal along congruent distribution tracks of phanerogamic vegetation. Raven (1973) and Takhtajan (1986) discuss the repeated long-distance dispersal of herbs across the tropics, mostly from California to Chile, during the Pleistocene. There is not a single genus of woody plants shared between the Mediterranean zones of California and Chile (Raven 1973), potentially eliminating the possibility of the relict persistence of *R. canariensis* between these regions. Additionally, the potential for mutual long-distance exchange between the African and Australian flora has been identified by di Castri (1991), who also emphasizes the importance of the "crossroads" position of the Old World Mediterranean basin. The occurrence of *R. canariensis* on mangroves in southeastern Australia (Stevens 1987) may reflect an additional mode for southern dissemination of this taxon, perhaps as an accompanying lichen epiphyte of mangrove migrations occupying dry or subhumid zones on the edge of the tropics that may have existed since the Paleocene (Raven and Axlerod 1978).

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BOREOPLACA ULTRAFRIGIDA, A NEW LICHEN GENUS AND SPECIES FROM CONTINENTAL SIBERIA

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SUMMARY

A new genus and species of squamiform lichens are described from an extremely continental area in Siberia. The species is saxicolous, and shows similarities with *Hypocenomyce*. The genus is tentatively placed in the Biatoraceae.

INTRODUCTION

During a lichenological expedition in Siberia in 1992, a lichen was collected which cannot be assigned to any previously described species or genus.

METHODS

Microscope sections were cut on a freezing microtome and placed in water, lactophenol cotton blue, chlor-zinc-iodine (ClZnI), and a modified Lugol's solution in which water was replaced by lactic acid. Amyloid reactions were observed in the modified Lugol's solution following pretreatment with 10% KOH. Polarized light was used to locate crystals in the sections. Thin-layer chromatography was performed in accordance with standard methods (Culberson 1972).

TAXONOMY

Boreoplaca ultrafrigida Timdal, gen. et sp. nov.

Thallus squamiformis, irregulariter rosulatus. Squamae ad 5 mm diam., adnatae, elongatae vel lobatae, cervinae; subtus corticatae, atrae. Cortex superioris reliquiis algarum. Stratum algaceum continuum; algae virides, unicellulares. Medulla non-amyloidea. Apothecia lecideina, atra, marginalia. Excipulum annulare, crystallorum plenum, C+ rubescens. Hypothecium incoloratum vel pallide fuscum. Hymenium 40–50 µm altum, amyloideum. Epithecium viridiater. Paraphyses laxae, simplices, apicem versus non-capitatae vel leviter inflatae. Ascus clavatus, tholo amyloideo. Sporae octonae, incoloratae, simplices, ellipsoideae vel subglobosae, non-halonatae. Pycnidia immersa, laminalia, pycniconidiis bifusiformibus.

Type: Russia, Yakutia, Ojmyakonskii region, c. 7 km WSW of Ust'-Nera, 64°32'N, 143°08'E, 500–600 m alt., 10 July 1992, Haugan & Timdal YAK03/39 (O, holotype; M, UPS, isotypes).

Thallus (Fig. 1A) squamiform, irregularly rosulate, developing along cracks in the substrate, up to 4 cm long and 1.5 cm wide. Squamules up to 5 mm diam., adnate, soon becoming elongated and lobed; upper side medium brown, epruinose, smooth or minutely wrinkled to partly cracked; margin and underside black; attached by 'Rhizinsträngen'. Upper cortex 50–75 µm thick (including a thin, up to 10 µm thick epinecral layer), evenly pale brown, composed of irregularly to mainly anticlinally arranged thin-walled hyphae with elongated lumina, filled with crystals (Fig. 1B) which dissolve in K, PD–, K–, C+ red, containing remnants of algae (Fig. 1C, ClZnI!). Photobiont layer 50–100 µm thick, continuous, containing unicellular green algae of up to 15 µm diam. (trebouxioid). Medulla lax, composed of loosely interwoven, irregularly arranged thin-walled hyphae with thread-like lumina, filled with crystals (Fig. 1B) which dissolve in K, PD–, K–, C+ red, non-amyloid, containing remnants of algae (Fig. 1C, ClZnI!). Lower cortex up to 40 µm thick, dark greenish black, lacking crystals, PD–, K–, C–.

Apothecia (Fig. 1A, D) lecideine, up to 2 mm diam., black, epruinose, dull, attached to the margin of the squamules in the central part of the thallus, aggregated, becoming angular, with a weakly concave to weakly convex disc and a rather thick, persistent margin. Excipulum annular, composed of radiating hyphae, olivaceous black in the rim (turning more green i K), pale brown to colourless in the inner part; inner part filled with crystals which dissolve in K, PD–, K–, C+ red, non-amyloid. Hypothecium continuous with medulla, colourless in lower part, pale brown in upper part (subhymenium), composed of loosely interwoven hyphae, not containing crystals, PD–, K–, C–, non-amyloid. Hymenium 40–50 µm high, lacking crystals and oil droplets, amyloid; epithecium greenish black (turning brighter green in K). Paraphyses weakly conglutinated, hardly branched and anastomosing, thin-walled, about 2.5 µm thick in the lower part, not or only weakly swollen (up to 3.5 µm) at the apex, lacking pigments in the cell wall but surface incrusted by green granules. Ascus (Fig. 1E) clavate, small, about 40 × 10 µm at maturity, when young with a small, pointed ocular chamber which later more or less disappears, surrounded by a thin amyloid sheet which is somewhat thickened over the ascus apex; tholus rather small, evenly amyloid except for a slightly darker amyloid zone bordering the ocular chamber. Spores eight in the ascus, colourless, simple, broadly ellipsoid to subglobose, non-halonate, 5–7 × 3.5–4.5 µm.

Pycnidia immersed laminally in the squamules, with a slightly protruding, greenish black pore; pycnidial wall containing crystals (Fig. 1B) which dissolve in K, PD–, K–, C+ red. Conidiophores short, branched, producing conidia apically (type III or IV of Vobis 1980). Pycnoconidia (Fig. 1F) bifusiform, 4–5.5 × c. 1 µm.

Chemistry: Lecanoric acid.

Ecology and distribution. The species is known from three closely situated localities near the town Ust'-Nera in the Indigirka river valley in Yakutia. It grew on steep, but not overhanging, faces of boulders in open situations. The holotype was collected from

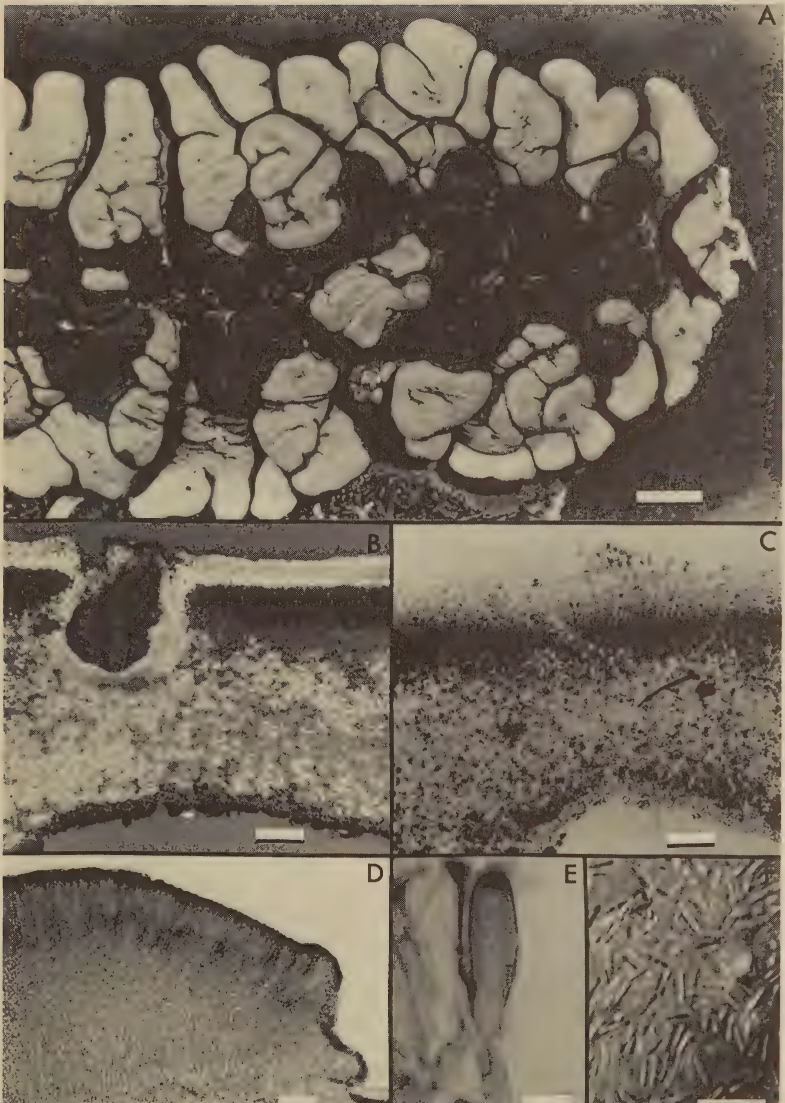

Figure 1. *Boreoplaca ultrafrigida*, part of holotype (O). A, habit. B, section through thallus in water, using polarized light, showing location of crystals. C, section through thallus in ClZnI, showing remnants of algae in the upper cortex and medulla. D, section through apothecium, in water. E, ascus, in a modified Lugol's solution after pretreatment in 10% KOH. F, pycnoconidia, in water. Bars: A: 2 mm; B–D: 100 μm, E, F: 10 μm.

a boulder in open *Larix* forest in a south-facing hillside; the two other collections were made from boulders in the alpine zone. Other lichens collected from the boulder at the type locality are *Anamylopsora pulcherrima* (Vain.) Timdal, *Dimelaena oreina* (Ach.) Norman, *Rhizocarpon renneri* Poelt, *Rhizoplaca subdiscrepans* (Nyl.) R. Sant., and *Umbilicaria muehlenbergii* (Ach.) Tuck. (all in O).

The localities are situated in the most continental area of the Northern hemisphere. The town Oymyakon, which is generally referred to as the 'cold pole' (Walter & Breckle 1986: 396), is situated in the same river valley about 120 km south of Ust'-Nera. A climatic diagram from Oymyakon is published by Walter & Breckle (1986: 364), showing a mean January temperature of about −50°C, a mean July temperature of about +16°C, a mean annual temperature of −16.3°C, and a mean annual precipitation of 131 mm. *Boreoplaca ultrafrigida* apparently belongs among species having a winter-cold, arid distribution; cfr the discussion on the distribution of *Gypsoplaca macrophylla* (Zahlbr.) Timdal by Poelt & Gärtner (1992).

Affinities. The species clearly belongs in the traditional *Lecidea* sect. *Psora* sensu Zahlbr. which is now split into several genera (cfr Schneider 1980, Timdal 1984b). Among the saxicolous and terricolous Asian species of this group (cfr Magnusson 1940, 1944, Hertel 1977, Golubkova 1981), a C+ red reaction occurs in *Anamylopsora pulcherrima*, *Lecidea subconcava* H. Magn., and *L. sinensis* H. Magn. Among other features, they all differ in chemistry and ascus type: *A. pulcherrima* contains alectorialic acid and has a *Trapelia*-type of ascus (Timdal 1991), *L. subconcava* contains gyrophoric acid, has a *Rimularia*-type of ascus, and belongs in *Rimularia* Nyl. (Timdal in prep.), and *L. sinensis* contains gyrophoric acid, has a *Lecidea*-type of ascus, and is closely related to *L. fuscoatra* (L.) Ach. (Hertel 1977: 277−279; holotype in S also examined by me).

The ascus type of *Boreoplaca* resembles that of the *Hypocenomyce friesii*-group, which is one of the four groups of species recognized in *Hypocenomyce* M. Choisy by Timdal (1984a). This group differs from *Boreoplaca* mainly in apothecium anatomy (carbonized exciple, dark brown hypothecium composed of closely conglutinated hypha), in having sessile pycnidia containing narrowly ellipsoid to shortly bacilliform conidia, and in containing different lichen substances. The anatomy of the apothecium and the thallus chemistry resemble that of the *H. scalaris*-group, which contains the type species of *Hypocenomyce*, *H. scalaris* (Ach.) M. Choisy. Unfortunately, well developed asci have never been found in the *H. scalaris*-group, and it is difficult to discuss its relationship with *Boreoplaca*. In the *H. scalaris*-group the pycnidia are sessile and the conidia bacilliform to filiform (Timdal 1984a). The four species comprising the *H. friesii*- and *H. scalaris*-groups are all lignicolous or corticolous; three of them show a preference for burnt wood (*H. scalaris* may also exceptionally grow on rock and soil). The species of *Hypocenomyce* form smaller (up to 2 mm diam.) squamules lacking a lower cortex.

It is not simple to place *Boreoplaca* and *Hypocenomyce* in the many families recently segregated from the Lecideaceae sensu Zahlbr. *Hypocenomyce* was tentatively placed in the Phyllopsoraceae by Hafellner (1984) and in the Lecideaceae by Eriksson & Hawksworth (1991). It seems to me that the poorly developed tholus observed in *Boreoplaca* and in the *H. friesii*- and *H. scalaris*-groups may be a result of reduction and possibly a parallelism in all three groups. Perhaps the presence of a small ocular chamber in young asci and the slightly darker amyloid staining in the zone bordering this chamber indicate a reduction from the *Bacidia*-type of ascus. If so, *Boreoplaca* may be placed in the Biatoraceae. However, bifusiform conidia seems to be an anomaly in the Biatoraceae, which contains mainly genera having filiform conidia. Among the squamiform species of the Lecideaceae s. lat. examined by me, bifusiform conidia occur only in *Gypsoplaca macrophylla* which belongs in the Gypsoplacaceae (this genus differs from *Boreoplaca* in several features, cfr Timdal 1990).

Additional specimens examined: Russia, Yakutia, Ojmyakonskii region, c. 7 km WSW of Ust'-Nera, 64°32'N, 143°08'E, c. 800 m alt., Haugan & Timdal YAK03/84 (O); c. 9 km SW of Ust'-Nera, 64°30'N, 143°10'E, 800–850 m alt., Haugan & Timdal YAK04/37 (O).

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PASSALORA EITENII SP. NOV. ON *SYAGRUS COMOSA* IN BRAZIL AND A KEY TO *PASSALORA* SPECIES

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ABSTRACT

Passalora eitenii sp. nov. is described and compared with 15 other known species of the genus. A key for the identification of *Passalora* species is also included.

INTRODUCTION

Syagrus comosa (Mart.) Mart. is a native species of Palmae abundant in the Cerrado region of Central Brazil, mainly at altitudes ranging from 700 to 1100m. In Brasília this palm is used as an ornamental. In its natural habitat *S. comosa* can sometimes be infected by the palm rust *Cerradoa palmaea* Hennen & Ono (Dianese, *et al.*, 1992) but more often this palm shows leaf spots caused by a dematiaceous hyphomycete that is herein described as *Passalora eitenii* sp. nov., and following, a comparison of its morphology with that of the fifteen known species of the genus (Viégas 1946; Petrak, 1949; Agnihothrudu, 1964; Deighton, 1967; Ellis, 1971; Ellis, 1976; Brown & Morgan-Jones, 1976; Kamal & Kumar, 1980; Adhikari & Manandhar, 1986; Rai & Kamal, 1986; Ruiz & Braun, 1989; Hsieh & Goh, 1990; Braun & Ruiz, 1991).

Etymology: After Dr. George Eiten, Brazilian-American Botanist, Professor of Botany and Ecology, Universidade de Brasília, famous for his works on cerrado vegetation.

***Passalora eitenii* sp. nov.** (Plate 1, A-H)

Maculae amphigenae, plerumque hyphophyllae, ellipticae, brunneae vel nigrae. *Coloniae* hyphophyllae, effusae velutinae, brunneae. *Mycelium* immersum. Hyphae septatae, ramosae, brunneae, glabrae. *Stroma* parvum, substomatale, textura angularis, 48-70μm diam. *Conidiopora* macronemata, mononemata, 3-12-caespitosa, non ramosa, 1-5-septata, vulgo 3-5-septata, glabra, brunnea, distilater flexuosa et plus geniculata 60-300 μm longa, 5-10 μm lata. *Cellulae conidiogenae* polyblasticae, sympodiales, integratae, terminales, interdum percurrentes, cicatricibus non conspicuis vel notatis. *Conidia* hyalina vel subhyalina, simplicia, sicca, acropleurogena, obclavata, laevia, transverse 1-3-septata, vulgo 1-septata, 27-55 μm longa, 2-7μm lata, cellulis proximis inflatis, hilis conspicuis ad basim, cellulae maxime strictae, subcylindricae.

In foliis vivia *Syagri comosae* (Mart.) Mart., palmae, in urbe Brasília, DF, Brasil, J. C. Dianese lectus in Herbari UB, Collectio Mycologica 881, holotypus.

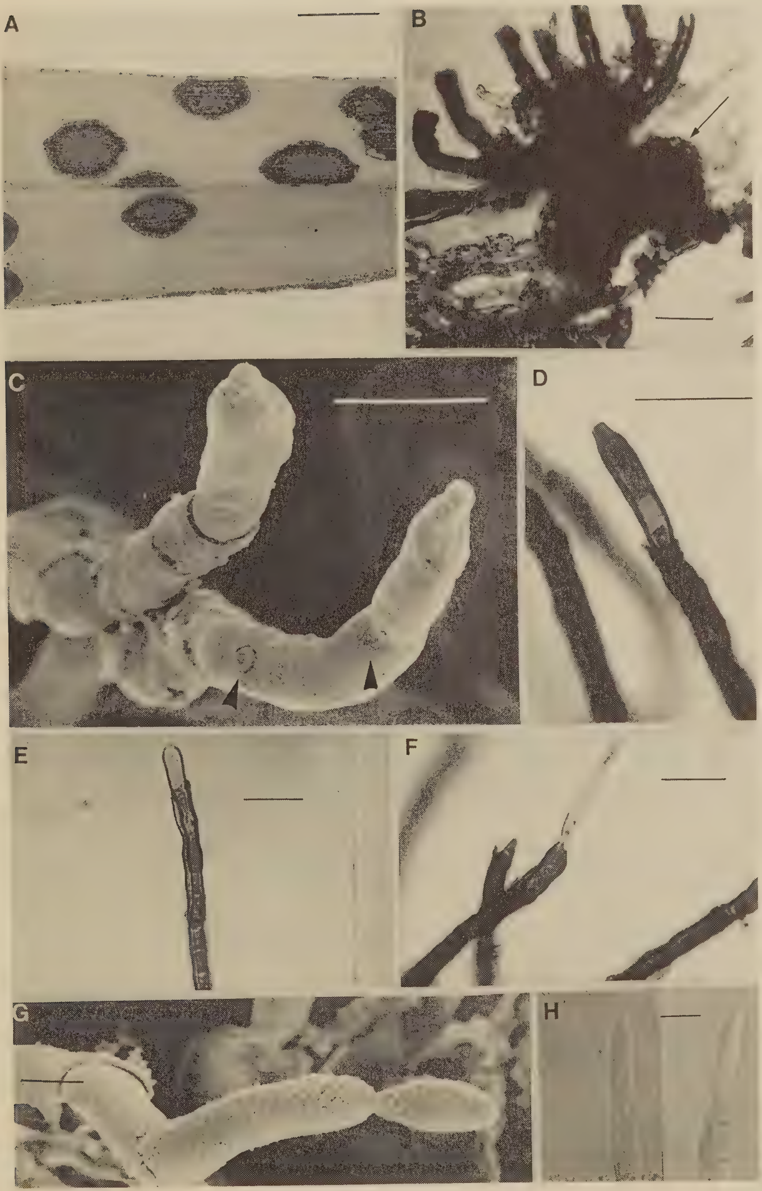
Leaf spots necrotic, dark brown to black, usually elliptical, rarely coalescent, lying longitudinally along the abaxial face of the leaflet, 2-2.5 x 10-15 mm (Plate 1, A). *Mycelium* immersed, branched, with 3-5 μm wide septate hyphae, pale brown to brown, *textura angularis* giving rise to a fascicle of conidiophores through the stomata (Plate 1, B). *Conidiophores* non-branched, simple, 3-12-caespitose, cylindrical, 3-5-septate, macronematous, mononematous, cylindrical, smooth, straight to slightly flexuous at the distal end, 60-300 x 5-10 µm, scars thin (Plate 1, C). *Conidiogenous cells* polyblastic, sympodial, integrated, terminal, sometimes proliferating percurrently (Plate 1, D-G). *Conidia* solitary, dry, acropleurogenous, 1-3-septate (mostly 1-septate), obclavate, hyaline, smooth, straight, thick-walled, rounded at apex, truncate at base, with a conspicuous hilum, 27-55 µm x 2-7 µm (Plate 1, H).

On leaves of *Syagrus comosa* (Mart.) Mart. in Brasília, Distrito Federal, Brazil, South America, Mycological Collection, 881, of the Herbarium of Universidade de Brasília, leg. J. C. Dianese, November, 1991, type UB.

Species of *Passalora* have been reported from twelve different host species in ten different families but for Palmae this is the first record. Species concepts with *Passalora* are at present based on septation and size of the conidiophores and conidia, number of conidiophores per fascicle, and presence or absence of rudimentary stroma. But, the proliferation of the conidiogenous cells has not been taken into account. The percurrent proliferation occurs in conidiogenous cells of *P. eitenii, P. bacilligera* (Ellis, 1971) and *P. indica* (Kamal & Kumar, 1980). However, *Passalora bacilligera* and *P. indica* differ from *P. eitenii* in several characteristics such as: *P. eitenii* forms a rudimentary stroma and fascicles with 3-12 conidiophores, whereas, *P. bacilligera* and *P. indica* do not form a stroma and have up to 15 conidiophores per fascicle and 3 per fascicle, respectively. The verruculose conidia of *P. indica* are clearly different from those of *P. bacilligera* and *P. eitenii*..

Besides *P. eitenii,* the only other species known on monocotyledonous hosts is *P. eragrostidis* which was also described from Central Brazil on *Eragrostis ciliaris* (L.) Link (Gramineae). However, the description by Viégas (1946) refers to a fungus with a hyaline, superficial mycelium which gives rise to conidiophores producing 2-celled, elliptical, verruculose conidia. Conidia germinating on the host surface produced new conidiophores. These characteristics are not in agreement with the generic concept adopted by Deighton (1967) for *Passalora* based on the type species *P. bacilligera* (Mont. & Fr.) Montagne & Fries. This indicates need for reclassification *P. eragrostidis* and therefore this species was not included in the identification key which follows.

PLATE 1. *Passalora eitenii.* **A**, necrotic lesions produced by this fungal species on the abaxial face of a leaflet of *Syagrus comosa* (Bar = 1cm); **B**, fascicles of conidiophores originated from a stroma (arrow) inside the stomatal chamber of *Syagrus comosa* (Bar = 20 µm); **C**, conidiophore with percurrent proliferation and scars (arrows) indicating sympodial growth of a conidiogenous cell. (Bar = 10 µm); **D-E**, conidiophores showing percurrent proliferation (Bars = 50, and 20 µm, respectively); **F-G**, conidiophores proliferated percurrently supporting conidiogenous cells with sympodial growth; **H**, conidia (Bar = 10 µm).


A
B
C
D
E
F
G
H

KEY TO *PASSALORA* Fries

1a. Conidiophores synnematous 2
1b. Conidiophores mononematous. 3

2a. Conidiogenous cells with both sympodial and percurrent proliferation; conidia
1-3-septate, verruculose, 32.5-55 x 7-10.5 µm; on *Celastrus paniculata*
. . . .*P. indica*
2b. Conidiogenous cells with sympodial proliferation only; conidia 0-1-septate,
smooth, 10-14 x 5-8 µm, on *Tephrosia candida*
. . . .*P. tephrodsiae*
3a. Conidiogenous cells with both sympodial and percurrent proliferation. 4
3b. Conidiogenous cells with only sympodial proliferation. 5

4a. Conidiophores up to 300 µm, apex not swollen; rudimentary stroma present
located in the stomatal chamber; conidia 0-3-septate, smooth, 27-55 x 2-7 µm,
on *Syagrus comosa* . . . . *P. eitenii* sp. nov.
4b. Conidiophores up to 180 µm, swollen at apex; stroma absent; conidia 1-3-septate,
21-68 x 4.5-8.5 µm; on *Alnus glutinosa* . . . . *P. bacilligera*
5a. Stroma present 6
5b. Stroma absent. 7

6a. Conidiophores up to 200 µm; not densely fasciculate (2-3 per fascicle); conidia
1-4-septate, 36-130 x 7-9 µm, on *Miliusae* sp. . . . . *P. annonacearum*
6b. Conidiophores up 50 µm; densely fasiculate (3-20 per fascicle); conidia
0-5-septate, 15-60 x 4-9 µm; on *Manihot esculenta* . . . . *P. henningsii*

7a. Conidiophores branched 8
7b. Conidiophores not branched 10

8a. Conidiophores multiseptate. 9
8b. Conidiophores 0-1-septate, up to 104 µm long, apex not swollen; conidia
0-1-septate, 26-87 x 4-7 mm; on *Alnus* spp. . . . . *P. alni*

9a. Conidiophores swollen at the apex, up to 360 µm long; conidia 0-1-septate,
constricted at the septa, 13-34 x 5.5-9 µm; on *Alnus incana*. . . . . . . *P. microsperma*
9b. Conidiophores not swollen at the apex, up to 85 µm long; conidia 0-3-septate,
not constricted at the septa, 13-36 x 4.5-5.5 µm; on *Stephania spp*. . . . *P. stephaniae*

10a. Conidiophores up to 470 µm long, up to 12-septate, up to 18 per fascicle;
conidia 1-3-septate, 27.5-60 x 3-8 µm; on *Alnus nepalensis*. . . . . *P. nepalensis*
10b. Conidiophores up to 130 µm long 11

11a. Conidia 0-1-septate, 18-32 x 10-14 µm, constricted at the septum;
on *Cousinia* sp . . . . *P. cousiniae*
11b. Conidia 0-6-septate, not constricted at the septa 12

12a. Conidiophores clavate with a swollen apex, up to 80 µm long; conidia
1-3-septate, verruculose, 25-60 x 7-10 µm; on *Evodia meliaefolia*. . . . . . *P. evodiae*
12b. Conidiophores not clavate, not swollen at the apex 13

13a. Conidiophores aseptate, up to 50 µm long; conidia 0-6-septate, 15-70 x 4-9 µm;
on *Bougainvillea spectabilis*. . . . . *P. bougainvilleae*
13b. Conidiophores septate 14

14a. Stroma present; conidiophores up to 130 µm long; conidia 0-2-septate, obclavate, 18-28 x 6-8 µm; on *Argemone mexicana*............ *P. guanicensis*
14b. Stroma absent or reduced to a few hyphae; conidophores up to 40 µm; conidia; 1-6-septate, cylindrical, 70-160 µm x 3-5 µm; *Psoralea* sp..... *P. nodosa*

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Book Reviews

L. M. Kohn, Book Review Editor

The Fungal Holomorph: Mitotic, Meiotic and Pleomorphic Speciation in Fungal Systematics, edited by D.R. Reynolds and J.W. Taylor. Hardcover, 240 x 160 mm, 375 pp., 1993. CAB International, Wallington, Oxon, OX10 8DE, UK [fax (0491) 833508]. ISBN 0-85198-865-2. £40.-- (U.S. $76.--).

This publication follows a conference of the same title held in Newport, Oregon, USA, 4-7 August 1992. The participants met to discuss the integration of classical and molecular characters in fungal systematics and the contentious issues surrounding the dual system for the classification of anamorphic and teleomorphic fungi.

The book's thirty-two chapters are organized in six sections and largely comprise brief reviews and research papers. The terminology employed in the title of this volume is taken from an overview of the fungal holomorph presented by Reynolds. The nomenclatural implications of the adoption of this terminology and the anamorph-holomorph concepts are the focus of separate chapters by Hennebert and Gams. The practical and theoretical considerations of the accomodation of anamorphic fungi in a holomorphic system of classification and nomenclature are addressed by specialists in chapters dealing with the systematics of specific fungal groups. Other chapters consider the question of evolution in anamorphic fungi and present phylogenies and anamorph-teleomorph connections inferred from nucleotide characters.

Two chapters are devoted to discussion of the central questions addressed at this workshop, *viz* the consequences of abandoning the Deuteromycotina and the development of a natural system of classification which includes anamorphic fungi. The conclusions of the discussion groups are condensed in a form that fails to convey the "lively, spontaneous give and take" sessions described by the editors. Transcripts of the debates which undoubtedly followed many of the contributed papers would have proved more informative, insightful and entertaining. Both chapters should have been included in the synopsis that serves to summarize the conclusions and recommendations of the conference participants.

This volume will appeal primarily to mycologists interested in the systematics and nomenclature of anamorphic fungi. A number of the contributed papers provide a valuable overview of classification that synthesizes traditional and molecular approaches. They will stimulate debate on the future development of the classification of fungi, an issue confirmed by this volume to be far from "moribund". *Wendy A. Untereiner, Department of Botany, University of Toronto, Ontario, Canada M5S 3B2*

Cortinaires. Diagnoses - Clés, by F. Trescol. Softcover, 230 x 148 mm, 4 volumes: Diagnoses Vol. 1, pp. a-k + 1-147 +1-55; Diagnoses Vol. 2, pp. 148-371; Clés Vol. 3, pp. 1-218; Clés Vol. 4, pp. 219-508, 1992-1993. Edition mycologique alesienne, 7 quai Jean Jaurès, 30380 Alès en Cévennes, France. FF 405.-- + port et emballage (postage).

This is an ambitious project wherein the author has reviewed the agaricological literature and provided short descriptions, habitat data, nomenclatural synonymy, literature citations and dichotomous keys to nearly all of the known species of *Cortinarius*. The scope of the work can be appreciated by the expressed exclusion of only two recent publications, the monographs of Horak and Moser on South American species of *Cortinarius*. These two works were excluded only because of their completeness. The four volumes of this work are arranged in two parts: specific diagnoses and taxonomic keys. The diagnostic volumes, Volumes 1 and 2, present their data as tabulated descriptions and references, each followed by the name of the species and its author. Each of these is in turn followed by a list of synonyms, both taxonomic and conceptual, and citation of references where these are discussed. The keys occupy Volumes 3 and 4. These are presented first as "flow charts" giving the overall structure of the keys and then as conventional dichotomous keys. The flow charts and the keys provide numbers for cross-reference to the descriptions.

I have used these volumes to identify a number of my own collections and find them to be extremely useful. In general the keys are well written and lead to accurate determinations. One omission that the authors might wish to consider for future editions is an index to species as they occur in the key. The diagnoses are short but contain most of the information needed by users. The format seems to have come from a computer database and is at first a little difficult to use. The lists of synonymy are especially confusing. However, after some study I was able to use it with ease.

The manuscript was prepared for camera-ready printing and was obviously being revised right up to the last minute. There are numerous handwritten changes scattered through the text. The printing appears to have been done on a photocopier in the last two volumes.

This is clearly a labor of love on the part of the author and represents a great amount of work. Although there are omissions, errors, and places where better cross-referencing would have been helpful, it contains such a wealth of information that these are easily overlooked. It is not expensive. Anyone who collects and identifies species of *Cortinarius*, including specialists, will find it to be a vauable addition to his or her library. *D. W. Malloch, Department of Botany, University of Toronto, Ontario, Canada.*

Die Grosspilzflora von Europa 1. Hygrophoraceae, by M. Bon, übersetzt und bearbeitet von A. Einhellinger. Softcover, 220 x 200 mm, 91 pp., 1992. IHW-Verlag, Bert-Brecht-Straße 18, D-8057 Eching [fax (49-89) 3192257]. ISBN 3-9803083-0-8. DM 48.--

Marcel Bon is one of the most productive mycologists of Europe. He described hundreds of new taxa and new combinations in innumerable short and long papers, in French, mainly in his own journal. DOCUMENTS MYCOLOGIQUES. It is an advantage for people interested in Hygrophoraceae that his knowledge on this group is combined in this publication which was originally published in French entitled *Flore mycologique d'Europe 1, les Hygrophores* (1990). The German version reviewed here, mainly differs in size (22 x 26 cm, instead of 22.5 x 16 cm) and a better lay-out. I could not find substantial discrepancies in the text after random comparison.

The book contains introductory chapters on the family concept and important diagnostic characters. A key is provided to the three recognized genera, *Hygrophorus*, *Hygrocybe* and *Cuphophyllus*. The core of the book comprises keys to the species and infraspecific taxa. The compact species descriptions are included in the keys. Most taxa are illustrated with drawings of a few spores and a small fragment of the pileipellis, in general of rather poor quality. In many cases notes on possible confusing taxa and nomenclature are given. The publication continues with a discussion on phylogenetic relationships, a bibliography, a list of synonyms and an index. The book concludes with reproductions of water colour paintings of 52 taxa by the author on six coloured plates.

It is evident that this publication is written by someone with a narrow species concept in comparison with other recent European revisions. Moser (1983) in his *Röhrlinge und Blätterpilz* described 68 species in *Hygrocybe* and *Cuphophyllus*, Hansen & Knudsen (1992) described 53 species in the Nordic macromycetes; Bon describes 86 species in this book as well as numerous varieties and formas. I have the impression that every slightly deviating collection seemed to deserve a name. Moreover, I could not discover much consistency in the taxonomic concepts. For instance, Bon distinguished five intraspecific taxa in the well-known *Cuphophyllus pratensis*, two of which are paler than the brownish orange typical var. *pratensis* : var. *vitulinus*, with a pinkish pileus and slightly darker centre, and forma (why not variety?) *pallidus* with a whitish pileus, very pale orange at the centre. According to a note (p. 17), Bon considers the latter form as a transition to *C. berkeleyi*, which is microscopically identical but almost entirely white. It is hard to understand why this taxon is not treated as a variety or form of *C. pratensis*. Another example is the separation of several species in *Hygrocybe conica* on the presence of 4-spored or 2-spored basidia, although it has been often demonstrated (and is discussed by Bon here) that many sporocarps have both types of basidia in different proportions. The concept of the family Hygrophoraceae is another curious phenomenon. Bon states (p. 15) that some Tricholomataceae could easily fit in the Hygrophoraceae on the basis of microscopic characteristics. One would expect that this weakens the position of the family, but, surprise, at the end Bon creates a new order Hygrophorales! Many more critical remarks could be made, also on the adapted nomenclature in some cases. Nevertheless, this publication is useful for students of this group of agarics, because it provides a compact compilation of widely scattered knowledge for a reasonable price. *E. J. M. Arnolds, Biological Station, Agricultural University, Wijster, 9418 PD, Netherlands.*

Check-lists for scientific names of common parasitic fungi, compiled by G. H. Boerema and Co-workers. Libri Botanici, Vol. 10. Softcover, 239 x 170 mm, 370 pp., 1993. IHW-Verlag, Bert-Brecht-Straße 18, D-8057 Eching [fax (49-89) 3192257]. ISBN 3-9803083-7-5. DM 78.--

For the past twenty-plus years G. H. Boerema and colleagues, under the aegis of the Netherlands Society for Plant Pathology, specifically the Commission for Dutch names of plant diseases, have carefully compiled a series of lists, previously published in the Netherlands Journal of Plant Pathology, of scientific names of plant-parasitic fungi. These lists were compiled in order to provide correct names of fungi with the "relevant" synonyms and also to document pathogenicity and distribution, emphasizing plant pathogens known from the Netherlands and surrounding countries. Of course, given the cosmopolitan distributions of many of these fungi, these lists have become a resource of nomenclatural documentation for mycologists and pathologists world-wide. This is an enormous piece of work, originally compiled on file cards, now scanned and compiled on computer. The resulting volume provides an important and useful set of papers collected in one volume.

Potential users should be aware of what this volume is and what it is not. It is a compilation of twelve articles published from 1972 to 1993 and a cumulative index. In order to use it, one must check every entry listed in the index for a species; a species may have been treated several times in several publications in the series. There is no synthesis under a single, easy-to-locate entry, as in *Fungi on Plant Products in the United States* (Farr et al., 1989, APS) or the *Compendium of Soil Fungi*

(Domsch, Gams and Anderson, 1980, reprinted in 1993 by IHW). The papers are grouped under four series: Fungi on trees and shrubs, Fungi on field crops, Fungi on bulbs, and Supplements (to the earlier lists on field crops) which were published most recently, 1987-1993. Users must be warned that the most recent reference is not a synthesis of the earlier references, but purely a supplement. The earlier references are cited, but in journal citations rather than pages occurring in this volume, making the cumulative index a life line to gaining access. This is not as convenient a desk reference as it might have been with more comprehensive reformatting. In any case, the highly admirable objective of the authors is to provide an evaluation of names in use "now", rather than a rigid scheme that precludes taxonomic and nomenclatural evolution. *L.M.K.*

Arctic and Alpine Mycology 3-4, Proceedings of the Third and Fourth International Symposium on Arcto-Alpine Mycology, edited by O. Petrini and G. A. Laursen. Bibliotheca Mycologica, Band 150. Softcover, 225 x 142, 269 pp., 269 pp., 1993. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, Johannesstr. 3 A, D-70176 Stuttgart, Germany [fax (0711) 625005]. ISBN 3-443-59051-9. DM 90.--

Proceedings of two previous International Symposia on Arctic and Alpine Mycology have been published in two preceding volumes. Many of the same participants contributed to ISAM 3, which was held at Svalbard, Norway in 1988. Due to delays in publication, the wise decision was made to combine the proceedings with those of ISAM IV, held at Lanslebourg, France in 1992. Twenty-one papers are presented, mainly taxonomic and floristic in focus, with one on Myxomycota, six on Ascomycota, 13 on Basidiomycota, and one on distribution patterns in parasitic fungi. Work is reported from sites as diverse as the Swiss Alps, Kamchatka, Greenland, subarctic Canada, Alaska, Fennoscandia, and the Falkland Islands. Of interest to taxonomists and biogeographers engaged in study of the northern or higher altitude mycobiota. *L.M.K.*

Illustrated Glossary of Protoctista, edited by L. Margulis, H. I. McKhann, and L. Olendzenski. Hardcover, 285 x 220 mm, 288 pp., 1993. Jones and Bartlett Publishers, One Exeter Plaza, Boston, MA 02116, U.S.A.[fax (617) 859-7675]; Jones; Jones and Bartlett Publishers International, PO Box 1498, London W6 7RS, England. ISBN 0-86720-081-2.

This volume is described in the subtitle as a "vocabulary of the algae, apicomplexa, ciliates, foraminifera, microspora, water molds, slime molds, and the other protoctists ... for students, teachers, and researchers...an illustrated, abbreviated version of the **Handbook of**

Protoctista." Clearly the **Glossary** is a condensation of the large, multi-authored **Handbook.** In the role of "teacher and student", I was pleased to have the opportunity to resource this book as a supplement to a well-regarded Biology text while teaching an undergraduate course called "Evolution and Diversity." The book includes two introductions, one to the book, one on nomenclature, a list of sources for living Protoctists, a progress report on database resources, a chapter on molecular systematics and Protoctist phylogeny, and the main body of the book, the illustrated glossary, followed by a bibliography and extensive classification scheme. We need this synthesis to make sense of the diversity in this huge, misunderstood group of organisms. We need this glossary. In its first incarnation, however, the **Illustrated Glossary** is a prickly fruit that does not easily yield its goodness.

I found the Margulis' Intruduction to be provative reading. I still do not see why "Protoctista" (what is the etymology here?) is preferable to the more euphonious Protista, although the implication of evolutionary antiquity posed by the later is probably not appropriate. Concepts can be clarified without new nomenclature. I hated "A universal feature of sexuality in eukaryotes is gender and the ability of complementary cells to recognize each other's gender." Why do Protists/Protoctists need **gender**? Does the more accurate "mating type" deflate their stature? Herskowitz's wonderful "Life cycle of the budding yeast *Saccharomyces cerevisiae*" (MICROBIOL. REV. 52: 536-553) with its discussion of mating type among eukaryotes offers a better perspective. Other chapters range in potential usefulness. Molecular Biology and Protoctist Phylogeny, for example, does not take up Protoctist phylogeny and offers very basic technical information readily available elsewhere. The glossary is very comprehensive and includes life cycle, ecological, and morphological terms, many of which are illustrated with photomicrograph of varying quality, line illustrations, and diagrams. The diagrams can be frightening in their complexity, especially the life cycles (e.g., see life histories of the Oomycota on page 53), cutaway diagrams (e.g., macrogamont on page 68), and one habitat diagram (page 51). I do not know any undergraduates who could understand these and they tried my patience. I suggest that in future revisions, the desire to compress information be tempered by a requirement for effective visual communication. I took issue with some of the life cycle definitions, some of which were unnecessarily complex (for inspiration read Dick Korf's 1952 NATURE paper on homothallism and heterothallism). Last, the authors should start working with the authors of university biology textbooks to bring their treatments of Protists up to current levels of knowledge; I am sorry to report that my text still lumps them under "plant-like", "animal-like", and, much to my horror "fungus-like" (sporozoans and slime molds) with "water molds" shuffled off in ignominious limbo. So much work to be done! I look forward to a revision of the **Handbook**, and companion **Glossary of Protoctista**. *L.M.K*

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